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Combat Vehicle Command and Control System Architecture Overview

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Armored Forces Research Unit
Training Systems Research Division

U.S. Army Research Institute for the Behavioral and Social Sciences

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EDGAR M. JOHNSON
Director

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Loral Advanced Distributed Simulation

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This Research Product describes and documents the software architecture used in the research and development effort referred to as Combat Vehicle Command and Control (CVCC). This effort was initiated in the late 80's and was conducted in the Mounted Warfare Test Bed at Fort Knox, Kentucky. CVCC incorporated futuristic requirements for command, control, and communications (C3) systems to be used by armored combat systems of the future. The nature of the program enabled an iterative approach to the development of a user-based system. This system provides modular software that can be tailored to varying levels of operational and experimental requirements. The Product also includes the catalog of CVCC software switches that support rapid configuration of the C3 features developed. Directions for future architecture development are provided in a catalog of change requests derived from user-based assessments.

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Combat Vehicle Command and Control System Architecture Overview

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FOREWORD

The Armored Forces Research Unit of the U.S. Army Research Institute for the Behavioral and Social Sciences (ARI) investigates training requirements for the future integrated battlefield using soldier-in-the-loop simulation. Research under this program is supported by Memoranda of Understanding (MOU) with (a) the U.S. Army Armor Center and Fort Knox, Subject: Research in Future Battlefield Conditions, 12 April 1989, and (b) the U.S. Army Tank-Automotive Command (TACOM), Subject: Combat Vehicle Command and Control (CVCC) Program, 22 March 1989.

The CVCC research program investigated advanced digital and thermal technologies to enhance mounted forces' command, control, and communications (C^3) capabilities. The CVCC system integrates a variety of digital features—report preparation and management, tactical map and overlays, transmission of reports and overlays—with positioning/navigation functions and independent thermal viewing for unit and vehicle commanders. The system also provides digital C^3 capabilities for workstations in a tactical operations center (TOC) digitally linked to vehicle-based CVCC systems.

This Research Product describes and documents the software empowering the futuristic C^3 capabilities derived under CVCC. Documentation is provided in the context of the simulated combat systems and operations used for CVCC company, battalion, and TOC evaluations. The research and development nature of the CVCC program enabled iterative development of a genuinely user-based software product. This software's modularity and compatibility with varying users' operational and experimental requirements are exemplified in the catalog of CVCC software switches that support rapid tailoring of the C^3 features developed. Directions for future architecture development are reflected in the catalog of change requests derived from user-based assessments.

This CVCC software architecture benchmarks many of the user-based features, derived in an operational setting, the Army will require for future automated C^3 systems. In fact, varied developmental efforts conducted by the Mounted Warfare Battlespace Lab (MWBL), TACOM, and System Training and Integration Command (STRICOM) have already obtained and utilized CVCC software in simulation research.

EDGAR M. JOHNSON
Director

PREFACE

The work described in this overview was originally conducted under the SIMNET program and subsequently under the Combat Vehicle Command and Control (CVCC) program sponsored by the U.S. Army Research Institute for the Behavioral and Social Sciences (ARI), Armored Forces Research Unit (AFRU), was continued under the umbrella of the Advanced Distributed Technology (ADST) program.

SIMNET was an advanced research project sponsored by the Defense Advanced Research Projects Agency (DARPA), in partnership with the U.S. Army, from 1983 to 1991. The goal of the program was to develop the technology to build a large-scale network of interactive combat simulators. This simulated battlefield provided, for the first time, an opportunity for force-on-force engagements against opposing units of similar composition.

Several core technologies were exploited in the SIMNET program to achieve a breakthrough in the simulation of forces and permit the use of such simulations in assessing the training impacts of the application of advanced components to armored combat vehicles. The technologies permitting this advance are

- high-speed microprocessors
- parallel and distributed multiprocessing
- local-area and long-haul networking
- hybrid depth buffer graphics
- special-effects technology
- unique fabrication techniques

These technologies, applied in the context of "selective fidelity" and "rapid prototyping" design philosophies, enabled SIMNET development to proceed at an unprecedented pace and allowed the early adaptation of the SIMNET research results into the CVCC program by the AFRU.

The thrust of the research conducted by the AFRU has been to apply SIMNET technology in the area of training and combat developments to aid in the definition and development of requirements for future weapon components and systems. This research thrust is feasible because of the relative ease with which the tank simulators can be modified in order to place a candidate system in a simulation of the combined-arms setting in which it is to be used and to interface its use by soldiers who would be called upon to operate the system in the real world. The CVCC program is an example of such work.

The CVCC program is a United States-German bilateral research and development effort sponsored by the U.S. Army Tank-Automotive Command (TACOM) to develop command, control, and communications (C3) systems and hardware for future armored fighting vehicles. As part of this effort, CVCC is conducting research into the technology for a fully automated, integrated, and interoperable C3 system for ground combat vehicles. The C3 system is intended to serve units at battalion level and below and to link adjacent units and cross-attached units.

The CVCC program was organized as four teams, each addressing a particular subject area. Team 1 was the Data Elements, Operational, and Organizational Concepts Team; it was chaired by the Directorate of Combat Developments, U.S. Army Armor School. Team 2 was the Communications Team, chaired by the U.S. Army Communications-Electronics Command. Team 3 was the Soldier-Machine-Interface and Simulation Team, chaired by the AFRU. Team 4 was the Vehicle Integration Team, chaired by the U.S. Army Tank-Automotive Command (TACOM). The efforts of the four teams are interdependent and mutually supportive.

Under the auspices of Team 3, the Future Battlefield Conditions Team of the AFRU conducted a series of evaluations systematically evaluating the various capabilities provided by advanced technologies, both digital and thermal, utilized in components simulating near real-time acquisition, processing, and dissemination of information providing digital map functions; digital message, reporting and overlay capabilities; automated navigation features (including a separate display for the vehicle driver); thermal viewing (with an integrated laser gunner's sighting system); and system-coupled digital battalion tactical operations center workstations for command, operations, and planning.

To conduct evaluations of digital and thermal advanced technologies there were two areas of the simulation network modification of the simulators incorporating a simulated command and control display, a simulated commander's independent thermal viewer, and a simulated driver's steer-to display and, second, software modification and development to simulate the technologies to be evaluated.

The physical modifications made to the simulators were accomplished by the Mounted Warfare Test Bed (MWTB) site staff and consisted of

- Mounting a 13" color monitor at the commander's station to accommodate the commander control display (CCD).
- Mounting a 10" monitor and control panel at the commander's station to simulate the Commander's Independent Thermal Viewer (CITV).

- Mounting a flat panel display at the driver's station to simulate the Driver's Steer-To display.

- Modifying and developing software evolved over the entire series of evaluations conducted under the CVCC program. As the research progressed, lessons learned in the earlier portions of the research were incorporated at each iterative step in the program.

As progress was made there are three major principles that guided the software department:

- Software was developed in modular fashion. This was a lesson learned early in the program and highly suggested for future efforts in the simulation facility.

- Soldier-Machine Interfaces (SMIs) were progressively modified based primarily on soldier participant comments in each iterative phase of the research.

- Iterative review of software functionality and interfaces by researchers and subject matter experts (SMEs) were conducted prior to installation of the software for the evaluation process.

- As explained in the body of this document certain software used early in the research process was embedded in the tank simulator software. It became apparent as the research progressed that it was much more useful and feasible to develop the experimental simulation software in functional modules. The CITV software developed early in the program is embedded with the tank simulator software. Later software developed, such as the CCD and the tactical operations center (TOC) workstation software, was developed in modular fashion.

Use of modular software allowed the simulation software to be rapidly reconfigured to meet research needs by using keyboard software switches (documented in this product). As each successive portion of the CVCC research was conducted and after action questionnaires and interviews of the soldier participants were completed, changes were made to the software and hardware. The questionnaires and interviews contained specific queries related to the SMIs presented in each portion of the research. These comments, in addition to SME observations, were used to refine the software in the next phase of the evaluations.

A systematic iterative approach to software development was derived and served to provide software that was effective and robust in relatively short periods of development. The approach is outlined as follows:

- Functional descriptions were prepared by SME.

- Coordination meetings were held between SMEs and software engineers.

- Story boards were prepared by the software engineers and were reviewed and modified by SME and researchers.

- An initial listing of measures of effectiveness and performance were made known to the software engineers at this time so that data elements could be inserted in the software.

- Interactive interface displays and controls were prepared using rapidly prototyped software and were retained at the MWTB for review by researchers and SMEs. Rapid feedback was provided to the software engineers.

- Software integration testing was conducted by the software engineers at the MWTB. At the conclusion of the integration testing, the software was demonstrated to researchers and SMEs. Feedback was provided during round table discussion.

- Initial operational software was delivered and installed. Functional testing was conducted by site staff and by researchers. The functional testing was also used to train the researchers and research assistants on the capabilities of the software. Feedback about bugs and required modifications were provided to the engineers daily.

- Bug fixes and modifications were incorporated and confirmed by researchers and SMEs.

- A functional test, utilizing soldier crews, was conducted to confirm the functionality, the training program, and data collection procedures.

- Final fixes to software, training, and data collection procedures were made.

- Formative evaluations were conducted.

As in any research program, not all software fixes were successful and many lessons were learned in each phase of the program. This document presents a picture of the software architecture at the conclusion of the CVCC battalion-level formative evaluation. The software is robust and functional, but even at this stage there remain bugs that have not been corrected and modifications that the researchers and the SMEs would like to have made.

Charles K. Heiden, P.E.
Maj Gen, U.S. Army (Rtd)

COMBAT VEHICLE COMMAND AND CONTROL (CVCC) SYSTEM ARCHITECTURE OVERVIEW

CONTENTS

CONTENTS (Continued)

COMBAT VEHICLE COMMAND AND CONTROL SYSTEM ARCHITECTURE OVERVIEW

THE SIMULATED WORLD OF THE CVCC MOUNTED WARFARE TEST BED (MWTB)

This part of the report describes what is simulated in the virtual world of the CVCC MWTB, how it is simulated, and how the pieces of the simulation work together.

What Is Simulated?

This section describes the various elements of the real world that are simulated in the virtual world of the CVCC MWTB. Figure 1 provides a conceptual view of these elements.

Terrain and Environmental Effects

The virtual world of the CVCC MWTB covers a 50x75-kilometer region around Fort Knox, Kentucky. The virtual world includes the terrain contours, vegetation (including tree lines and tree canopies), rivers, and man-made objects such as roads, buildings, and bridges.

In addition, a limited number of environmental effects, such as the time of day and the effects of haze on visibility, are included. These were not utilized during the CVCC formative evaluations.

Combat Vehicles and Combat Forces

The world of the CVCC MWTB focuses on force-on-force warfare at the battalion level and below. The friendly forces consist of an armored tank battalion of the U.S. Army with normal artillery support. The opposing forces consist of armored regiments organized according to the doctrine of the former Soviet Red Army.

The following types of equipment are represented:

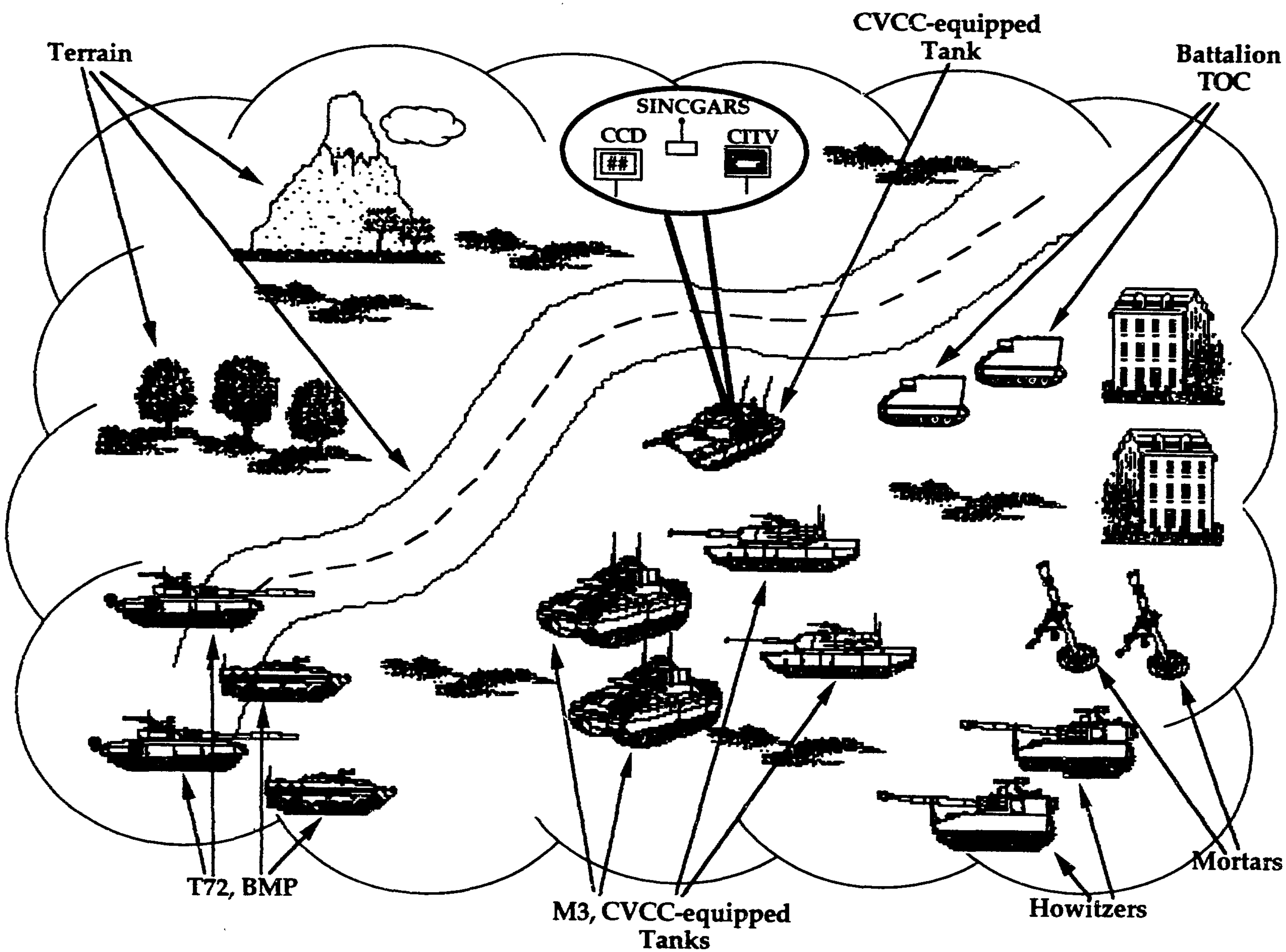


Figure 1. Real world elements simulated in the virtual world.

- CVCC-equipped tank
- M3 Bradley Fighting Vehicles
- Howitzers
- Mortars
- T72 tanks
- BMPs

The CVCC-equipped tank is an M1 tank enhanced with various weapons and command and control systems, including the Commander's Independent Thermal Viewer (CITV) and the Autoloader System, the SINgle Channel Ground/Air Radio System (SINCGARS), and the Command and Control Display (CCD).

The CITV is mounted on the turret and is capable of slewing independently of it through 270 degrees of rotation, providing the commander with an infrared view of the battlefield. In addition, an Identification Friend or Foe (IFF) System has been built into the CITV, allowing the Commander to view the IFF symbol for a potential target. The CCD is located in the commander's station in the tank.

The Autoloader enhancement to the CVCC tank removes the onus of manually loading the ammunition for the tank. Thus, the role of the loader need not be filled in a tank equipped with an autoloader, so that the tank could be fully manned with only 3 crew members. Mechanical prototypes of autoloaders have been built for the M1, though none have ever been fielded. The CVCC tank incorporates this capability.

The SINCGARS radio is a new family of VHF-FM combat network radios designed to provide the primary means of command and control for combat units, combat support units, and combat service support units in the Army. SINCGARS radios improve on the previous generation of tactical radios by providing more channels, better communication security, better Electronic Counter-Counter Measure (ECCM) capability, and greater reliability. The SINCGARS family includes a series of modular components that can be combined in different configurations to produce a variety of "manpack," table-top, and vehicle-borne radios. In the CVCC MWTB, a SINCGARS simulation provides the communications link for tank-to-tank, tank-to-TOC, and TOC-to-tank communications.

The CCD is a prototype of a vehicle-based Command and Control system that allows the tank commander to send, receive, and manipulate various types of command and control data including:

- vehicle location information (POSNAV)
- vehicle status information, such as fuel and ammunition status
- Army reports, such as Spot reports, Contact reports, and Call-For-Fire (CFF) reports
- graphical overlays such as OpOrds and Fire Support overlays
- Driver's Steer-to

Battalion Tactical Operations Center (BnTOC)

In addition to the CVCC-tank based CCD, the world of the CVCC MWTB supports command and control functions through the simulation of the Battalion Tactical Operations Center using the computer-based BnTOC workstations. Together with the CCD, the introduction of the BnTOC workstations into the CVCC MWTB represents a bottom-up attempt at integrating computer-based command and control systems into the battlefield. The BnTOC workstations provide the connecting link between the battalion staff and the CVCC-tank based CCDs. They were built in response to the need to support battalion-level CVCC experiments and to allow the CCD-equipped tank simulators to communicate digitally with the BnTOC.

Currently, the CVCC simulation includes five different workstations (not all required functions were implemented in these workstations due to time and funding restraints). The workstations are:

- Planning workstation
- Operations workstation
- Intelligence workstation
- Fire Support workstation
- Combat Service Support (CSS) Workstation

An additional workstation is available to drive a 6x4 foot electronic Situation Display. Future work in the MWTB could add a workstation for the personnel function.

BnTOC workstations allow the TOC officers to digitally send and receive the same command and control information as the tank commanders (with the exception of vehicle status information which the BnTOC workstations can only receive). The BnTOC workstations give the TOC officers computer-based assistance in planning and conducting a battle. For battlefield and mission planning, the BnTOC workstation provides a tactical map and the ability to edit a rich variety of graphical overlays, including operations, intelligence, and concept-of-operations overlays (which provide information about the movements of units through various phases of an operation). During the actual battle, the BnTOC provides an integrated environment in which reports from the battalion's combat vehicles can be quickly and easily integrated into the evolving picture of the battlefield situation as summarized in the form of graphical overlays, and quickly shared with the appropriate parties, including the company commanders and other battalion TOC officers. The software is configured so that each BnTOC workstation has access to files belonging to the other BnTOC workstations, in effect creating a shared database of command and control information and allowing rapid integration of operations, intelligence and logistical information.

CCD and the BnTOC workstations both use SINCGARS as their transmission medium. Figure 2 shows how the SINCGARS, CCD, and BnTOC systems work together to form a hierarchical Battalion Command network in which an individual tank can transmit voice and data up to the battalion headquarters and potentially beyond to brigade and division level. All tanks in a particular command network can send and receive voice and data to all other tanks on that network. In addition, the commander of a particular unit can communicate information up the chain of command to the next higher command network. In this way, information flows up the chain of command from the individual tanks belonging to a platoon-level command network, to the corresponding company and battalion command networks. In like manner, intelligence information and command and control data flow down through successive echelons.

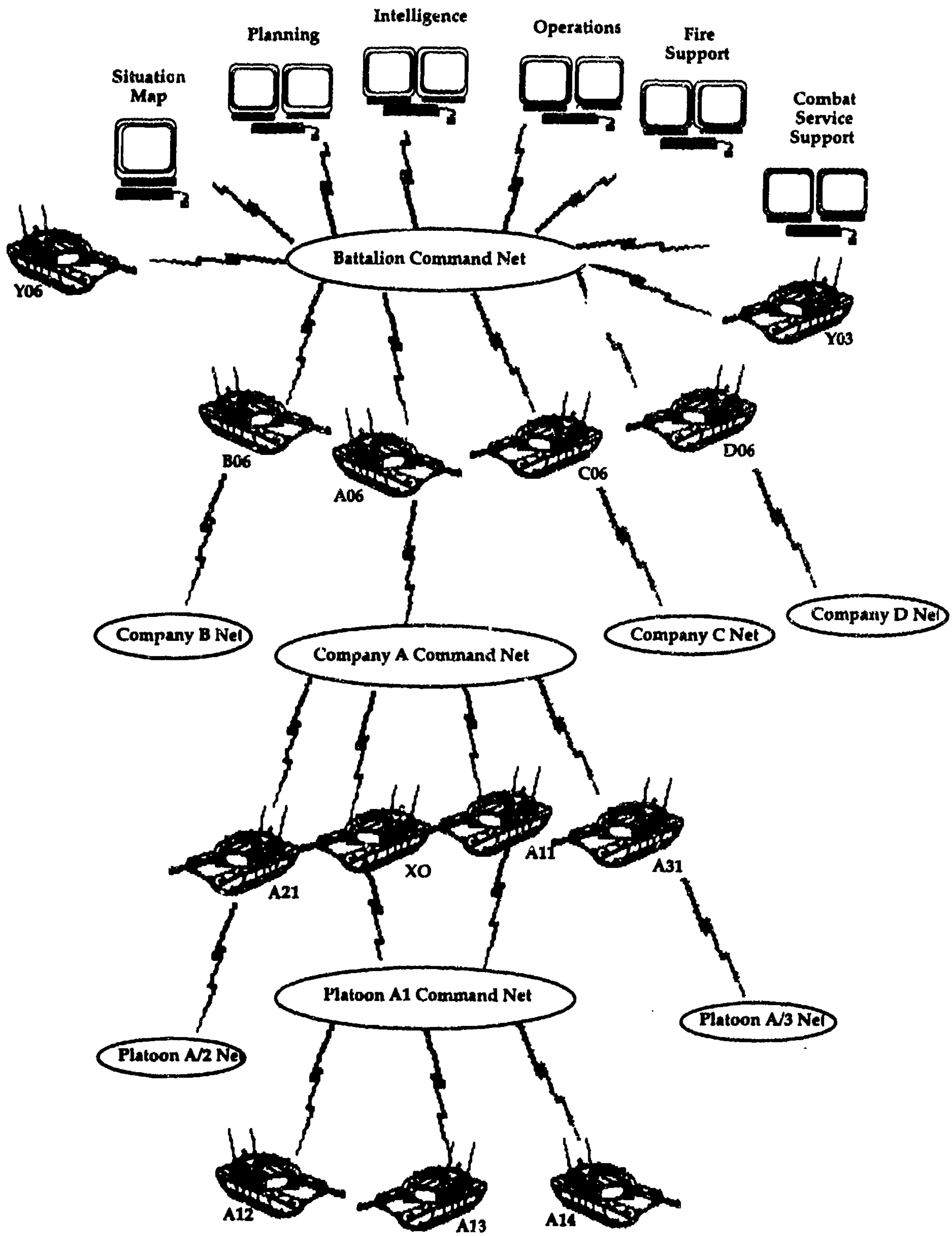


Figure 2. CVCC command networks. (Each CCD simulator is identified during an exercise by its unique "call sign," e.g., Y06, A06.)

How Is It Simulated?

This section explains how the elements of the real world described above are simulated (see Figure 3). It describes the following major software and hardware systems of the CVCC MWTB and what they simulate. It also describes how these systems interact and communicate with one another:

- Terrain databases
- CVCC manned and unmanned vehicle simulators
- BnTOC Workstations
- Data analysis systems

Figure 4 provides an overview of the simulation network.

Terrain Databases

Each system participating in the simulated battlefield of the CVCC MWTB uses a copy of a common terrain database that describes a 50x75-kilometer area around Fort Knox, Kentucky. This terrain database is derived from Level I Defense Mapping Agency Data consisting of soil type and elevation data sampled at 90-meter (3 arc second) intervals. This DMA data is enhanced with microterrain (hills) and feature data (buildings, railroads, etc.) and converted into two different formats for use by systems in the CVCC MWTB. One format primarily uses polygons in three dimensions to describe all the objects in the terrain. This format is well suited for use by the Computer Image Generator (CIG) which produces the "out-the-window" views for the manned vehicle simulators. The second format is a simplified version of the first in which the three-dimensional information is collapsed into two dimensions. This format is well suited for systems that require only a two-dimensional view (i.e., a map) of the terrain. In either format, the database includes terrain features such as contours, rivers, and vegetation, as well as man-made cultural features such as roads, buildings, and bridges. For a more detailed description of the process of S1000 Terrain Database Generation, see Appendix B.

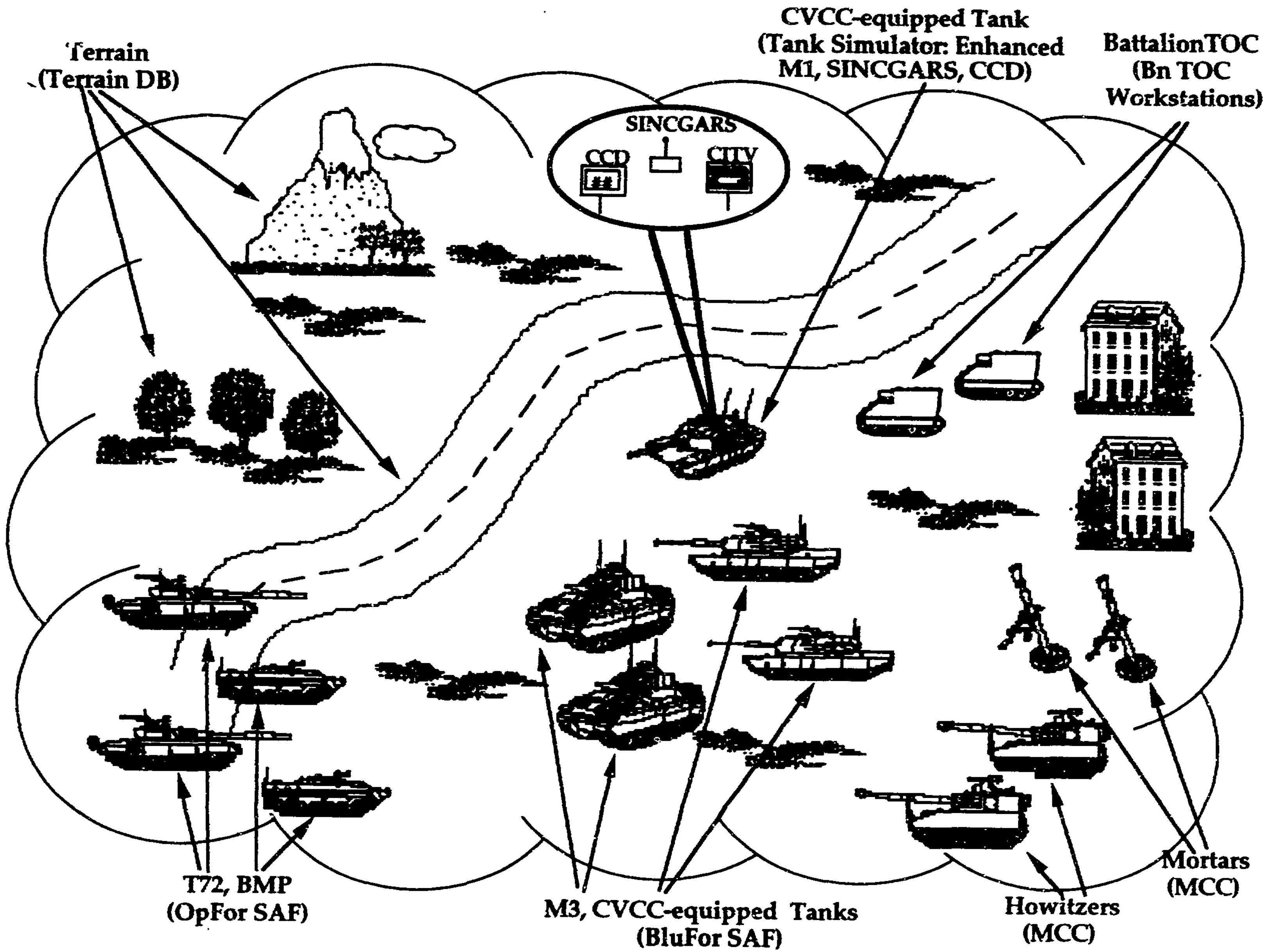
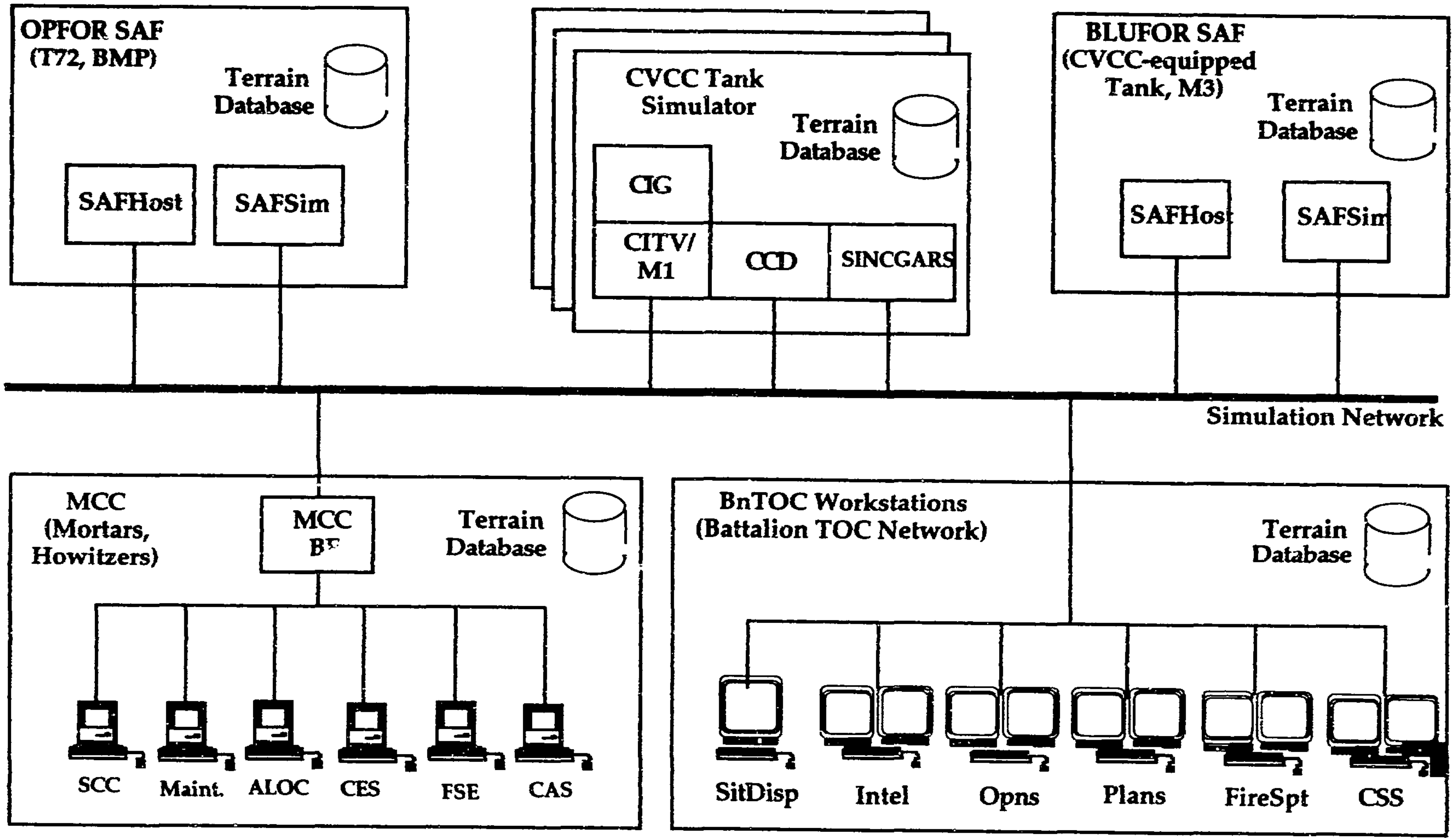


Figure 3. How real world elements are simulated in the virtual world.



ALOC	Administration and Logistics Console
BLUFOR	Friendly Forces
CAS	Close Air Support Console
CES	Combat Engineering Support Console
CIG	Computer Image Generator
CSS	Combat Service Support
FireSpt	Fire Support Officer Workstation
FSE	Fire Support Element Console
Intel	Intelligence Officer
MCC	Management, Command, and Control
OPFOR	Opposing Forces
Opns	Operations Officer
Plans	Planning Station
SAF	Semi-Automated Forces
SAFHost	The front end of the Semi-Automated Forces System
SAFSim	The back end of the Semi-Automated Forces System
SCC	Simulation Control Console

Figure 4. CVCC MWTB simulation network.

CVCC Manned and Unmanned Vehicle Simulators

Simulating friendly forces involves both manned and unmanned vehicle simulators. Simulating opposing forces involves unmanned vehicle simulators only.

Manned vehicle simulators allow the "live play" caused by human decision-making and human error to become a part of the simulation. Manned simulators usually include the following major subsystems:

- an enclosure that replicates the interior of the vehicle being simulated
- controls, sensor displays, and out-the-window displays for the crew
- computer image generators (CIGs) for out-the-window and sensor views
- a visual model of the appearance of all dynamic entities in the exercise
- a sound system
- a host computer called the SimHost, which runs the software model of the vehicle and associated weapons systems
- a connection to the simulation network

Unmanned vehicles in the CVCC MWTB are primarily generated using the Semi-Automated Forces (SAF) system.

Manned Simulators: The CVCC Tank

In the CVCC MWTB, the only manned vehicle simulators used are CVCC-equipped tanks. The CVCC enhancements include:

- the Commander's Independent Thermal Viewer (CITV)
- the Autoloader
- the SINCGARS radio
- the CCD

The CITV and the Autoloader were both implemented as extensions to the core M1 manned vehicle simulator software.

As with out-the-window views, the CIG and the SimHost cooperate to produce the simulation; the SimHost determines what is viewed, and the CIG generates the views. The SINCGARS and CCD capabilities are implemented as software systems that are completely separate from the enhanced M1 vehicle simulator. Details on how these simulations are constructed and how they cooperate to form the complete CVCC simulation are provided in the section describing the BnTOC Workstation. For CVCC Tank simulator operator instructions, see Smith, 1991.

CITV simulation.

The CITV simulation provides a two-axis stabilized thermal viewing platform independent of the tank gunner's view. The thermal viewer provides both low and high magnification and a choice of either white hot or black hot viewing modes. The commander may access a number of capabilities of the CITV simulation, described below, from controls located around the CITV display and on the commander's control handle. Figure 5 depicts the CITV display and its relationship to the CCD display. The following capabilities are provided with the CITV:

- Independent Laser Range Finder (LRF): Provides the capability to lase a selected spot on the battlefield. When the commander lases a location, the range to that destination is displayed on the CITV. This capability is often used to lase a vehicle, to determine its range. The lasing function is also used as the basis for other CITV functions.

- Manual and Automatic Thermal Scanning of the Battlefield: Provides an independent ability for the commander to observe the battlefield. The commander is provided the ability to select 3 and 10 power magnification, manual control of battlefield surveillance or automatic scanning between commander defined right and left limits of scan.

- Integrated Reporting: This capability provides integration of the CITV and CCD. If the CCD is in report creation mode when the LRF is used and an active location field is present in the report, the CCD uses information provided by the CITV to automatically fill in that field with the lased location in standard six-digit UTM map coordinates.

- Identification Friend or Foe (IFF): Simulates the ability of an automated Identify Friend or Foe system by depicting an IFF symbol in the upper left hand corner of the CITV display whenever a possible target is lased. Probabilities of obtaining an accurate identification are range based, and can produce incorrect results at long ranges.

- Target Designation: Allows the commander to designate a current target location by causing the turret and gun to automatically slew so that the gunner's sight is on the target.

- Target Stack Capability: Allows the commander to establish up to four (4) target tracks in a stack. The gunner subsequently selects a target from the stack and the turret and gun automatically slew in azimuth so that the gunner's sight is laid on the predicted azimuth of the target. The Target Stack Capability was not used during the battalion formative evaluations.

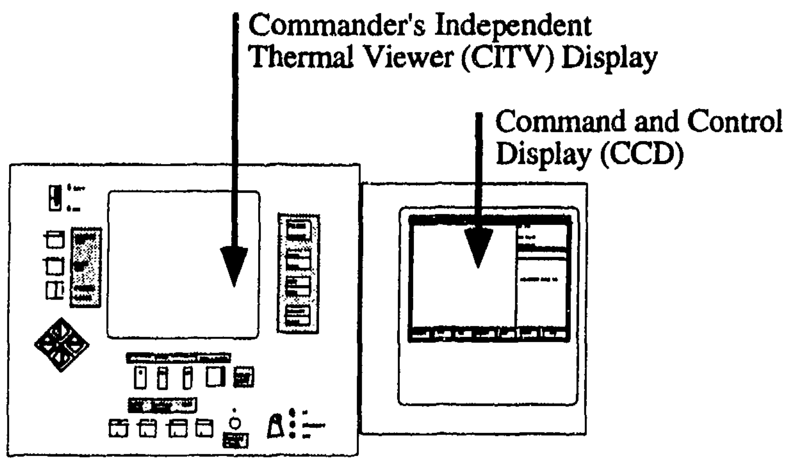


Figure 5. CVCC displays.

Autoloader simulation.

The Autoloader simulation provides an autoloading capability for the CVCC tank simulator main gun. This capability performs the role of the loader, by automatically loading the selected ammunition for the tank. Since this function is performed automatically, no separate controls or capabilities need to be accessed by the crew of the tank. Further, since the role of the loader is automatically filled, a CVCC tank simulator can be fully manned with only three crew members.

The Autoloader functions as follows:

- From trigger pull, the gunner has a 3 second pause to change ammo types if he so desires; otherwise the autoloader will load the same type round.

- Total cycle time from trigger pull until the "loaded" light comes on is 8 seconds.

- If the gunner changes the ammo type by changing his selector switch after a new round is loaded the autoloader will unload and reload with the new type of ammo - time is 8 seconds.

The times to reload and reposition main gun rounds from hull stowage or from another tank were not changed from the baseline M1 simulator.

<u>SINCGARS simulation</u>.

Two types of SINCGARS radios are simulated in the CVCC MWTB. The table-top model is used in the battalion TOC for TOC-to-tank communications. The vehicle-based model is part of the overall CVCC tank simulation and is used for tank-to-tank and tank-to-TOC communications. A single software program is used for both models, and the capabilities are virtually identical.

The SINCGARS radio simulator has a front panel with controls that look like and selectively function in the same way as those in the real radios. It has Input/Output (I/O) hardware that includes Analog to Digital (A/D) and Digital to Analog (D/A) converters, and a processor to digitize and compress speech, making the speech ready for efficient transmission on the local-area network (LAN). The radio simulation includes a software-based Radio Interface Unit (RIU), which negotiates between voice and data transmissions. It has the ability to simulate the frequency-hopping capabilities of the real SINCGARS radio, and it includes a propagation model that accounts for effects such as attenuation of signal strength, jamming, and terrain interference.

<u>CCD simulation</u>.

The CCD simulation uses a 13-inch, full-color, high-resolution cathode ray tube (CRT) monitor as the basis for the display in the tank commander's station. The simulation uses a graphical user interface (GUI) based on Open Software Foundation's (OSF) Motif to implement all of the controls in software. The input devices include a touch screen mounted over the display and a thumb controller mounted in the commander's control handle. In addition, there is a connection to the simulation network and an interface to a "steer-to" display in the driver's compartment.

The software includes a map module, which implements the tactical map to display terrain features similar to those on a topographical map and to send, receive, and display graphical overlays. A navigation module provides the ability to edit, send, receive, and display routes. The routes consist of a series of waypoints that appear on the tactical map when the route is displayed. The navigation module also sends waypoint information to a steer-to display mounted next to the steering T-bar in the driver's compartment. A report module provides the ability to edit, send, receive, and display formatted Army reports (e.g., Spot, Contact, CFF, Intel). When a report is displayed, location information contained in it is displayed in the form of icons on the tactical map. These icons can then be "posted" to the tactical map, causing them to remain visible until they are explicitly removed. An operational effectiveness module combines the vehicle status information (ammunition, equipment, fuel, and personnel) into graphical reports that summarize the operational effectiveness of the vehicle and the unit to which the CCD belongs. A fire support module helps the user to construct Call-For-Fire (CFF) reports based on UTM coordinates or Target Reference Points (TPRs). Finally, a communications module provides the capability for communications either directly on the network or via a SINCGARS radio simulation for the full array of command and control information, including vehicle location, graphical overlays, routes, reports, and vehicle status.

Semi-Automated Forces (SAF)

Unmanned vehicles in the CVCC MWTB are primarily generated using the Semi-Automated Forces (SAF) system. One SAF operator can control about 60 SAF vehicles. To human participants, SAF vehicles are usually indistinguishable from manned simulator vehicles because they send the same data packets over the simulation network as manned simulators. SAF vehicles can do many things on their own. The SAF operator needs to direct the SAF vehicles only at a high level, such as moving them from one location to another or instructing them to attack the enemy. The SAF vehicles fill in many of the details, including establishing correct formations, plotting and following routes, and engaging or fleeing from the enemy.

The SAF simulators include the following major subsystems:

- The SAF Station, or front end, provides a Graphical User Interface (GUI) from which the user can create and control groups of vehicles organized according to the doctrine of the armed forces of a number of different countries, including the United States, Germany, and the former Soviet Union.

- The SAFSim, or back end, simulates the vehicles requested by the user, and controls their actions in response to the high-level commands from the front end.

SAF can be used to simulate a wide variety of vehicles, including tanks, fixed-wing aircraft, helicopters, howitzers, mortars, personnel carriers, and supply and logistics vehicles. In the CVCC MWTB, SAF is used to generate the CVCC-equipped tanks and scout vehicles (M3s) for the friendly forces as well as all the opposing forces. The friendly force vehicles (BLUFOR) can dispatch digital messages formatted in the CVCC format into the C3 system.

Using SAF makes it possible to run larger exercises without having to man every vehicle. Because multiple unmanned vehicles can act as a unit and have a high degree of intelligence and independence, they can be combined with manned vehicle simulators in various ways. The configuration of manned and unmanned vehicle simulators being used for the battalion-level CVCC experiments is a good example of this flexibility. Manned vehicle simulators are used for the key command positions, including the tanks belonging to the Battalion Commander, S3, and A, B, and C Company COs and XOs. All remaining tanks in the Battalion are unmanned SAF vehicles: the Scout platoon of M3 vehicles, platoons 1, 2, and 3 of companies A, B, and C, and all the tanks belonging to Company D. In the companies consisting of a mixture of manned and unmanned vehicles, the platoons of unmanned vehicles are "tethered" to the company commander's vehicle, allowing them to move and act more as a single cohesive unit rather than 3 separate units. In the company-level CVCC experiments, manned vehicle simulators were used for the company headquarters section, and for one of the platoons. The other platoons were simulated by SAF vehicles. Here, too, the SAF platoons were "tethered" to the company commander's vehicle in order to force them to act more as a cohesive unit.

For both the company- and battalion-level experiments, the friendly SAF tanks were enhanced to behave more like CVCC-equipped tanks. The enhancements included alterations to the target acquisition tables to simulate the presence of a CITV and the ability to send vehicle location (POSNAV, or

POSition NAVigation) information, vehicle status information, and army reports, thus simulating the output of a CCD. All these enhancements helped to make the SAF tanks indistinguishable from manned CVCC-equipped tanks in the simulated world of the CVCC MWTB. To create a consistent environment, the CVCC capabilities as outlined above were provided for the CVCC M3 vehicles in the Scout platoon as well.

The Management, Command, and Control (MCC) System

A second system used in the CVCC MWTB to generate unmanned vehicles is the Management, Command, and Control (MCC) system. The MCC is a set of consoles that allow exercise control and provide logistics and combat support. The MCC stations include a master console for exercise control called the simulation control console (SCC) and five other consoles that provide GUIs for repair and recovery, resupply (fuel and ammunition) called the administration and logistics console (ALOC), combat engineering support (CES), fire support element (FSE), and close air support (CAS) roles during an exercise. In the CVCC formative evaluation not all of these capabilities were necessary or utilized. Each of these consoles communicates with the MCC backend which, like the SAF Sim, is responsible for controlling the unmanned vehicles. In the CVCC MWTB, the MCC vehicles have fewer capabilities and less built-in intelligence than SAF vehicles.

In the CVCC MWTB, the MCC is used to generate the howitzer and mortar vehicles for the simulated world. These vehicles can execute various types of fire support functions, including pre-planned fires and calls-for-fire. One limitation of these MCC vehicles is that they are not visible when traversing the terrain. They disappear from the simulated world for the time that they require to travel from one place to another, and then reappear at the destination. In effect, MCC vehicles are teleported, though the teleportation takes the appropriate amount of time.

BnTOC Workstation

The BnTOC workstation has two full-color, 19-inch monitors connected to an engineering workstation. The simulation uses a GUI based on OSF Motif to implement all of the user controls.

The BnTOC workstation shares all of the software capabilities of the CCD simulation except the navigation module. It also has a number of additional capabilities, which are enumerated below.

The map module in the BnTOC workstation provides the ability to edit graphical overlays in addition to sending, receiving, and displaying them. The BnTOC workstation also handles a special type of overlay, a concept-of-operations (COO) overlay, not available in CCD. The COO Submodule enables the user to edit and display concept-of-operations overlays on the tactical map. Concept-of-operations overlays consist strictly of unit icons belonging to an organic task organization hierarchy such as an armor battalion. The task organization hierarchy can be de-aggregated to the desired level, and each of the resulting unit icons in the task organization can be placed in a series of battlefield locations corresponding to the unit's battle positions for the various phases of the operation. By stepping the unit icons through their battle positions, the user can reveal the operation phase by phase.

The BnTOC workstation has an enhanced operational effectiveness capability, including different types of reports and a greater ability to determine the status of specific elements of the battalion. In CCD, the tank commander has access to reports summarizing the status of his own tank or his own unit with regard to fuel, ammunition, or equipment. These reports are bar charts that display the amount available and the amount consumed. In the BnTOC workstation, the TOC officer can display these reports for any unit within the battalion and for the battalion as a whole. In addition, the TOC officer can display summary reports that show the fuel, ammunition, equipment, and personnel status simultaneously in the form of a standard Army GARB pie chart.

The BnTOC workstation includes a <u>format module</u>, a job-aid which assists the user in creating a variety of Army reports and documents (e.g.: Est/Sit, OpnOrd, INTSUM, etc.).

The <u>BnTOC network</u> as configured in the CVCC MWTB includes a total of six BnTOC workstations. Three are used to support the battalion staff officers including an S2 workstation for the intelligence officer, an S3 workstation for the operations officer, and a Planning workstation for the battalion commander and executive officer. A fourth workstation is used by the fire support coordinators assigned to the battalion TOC from the divisional artillery battalion. A fifth workstation is used to support the logistic function and to assist in exercise control, and a sixth workstation is used to drive the electronic situation display (SitDisp).

After-Action Review, Data Analysis, and CVCC Utilities

Several systems that are part of the CVCC MWTB do not play an active role in creating the simulated world. Rather, these systems support the simulation and the use of the CVCC MWTB as an experimentation testbed. These systems can be divided into three categories:

- After-action review
- Data analysis
- CVCC utilities

After-Action Review

Three separate systems are combined to provide the after-action review (AAR) system in the CVCC MWTB. They are the stealth vehicle, the data logger, and the plan view display. The AAR system is used to determine what part of a recorded exercise should be played back. It provides capabilities similar to that of a tape or video recorder, including play, rewind, fast forward, and search modes. Using the stealth vehicle, data logger, and PVD, the operator can see a two-dimensional and a three-dimensional view of any portion of the exercise from any position in the terrain database.

The stealth vehicle, as its name implies, provides a window onto the battlefield without being seen (Katz, 1990). Because the stealth vehicle emits no data packets (see the section on the simulation protocol), it is invisible to all participants and cannot affect the exercise. The stealth vehicle is very useful for AAR because of its ability to move quickly to any location on the battlefield and view the battlefield from any direction. A stealth vehicle includes:

- a control to manipulate the stealth view in six degrees of freedom
- a computer image generator (CIG) for out-the-window views
- a sound system (optional)
- a simple first-order model for the vehicle dynamics
- a visual model of the appearance of all other dynamic entities in the exercise

- a connection to the network

- a terrain database

The data logger supports the AAR functions by providing recording and playback functions much like those of a tape recorder. In recording mode, the data logger uses its connection to the network to save all the packets sent over the network during an exercise, along with a timestamp indicating when they arrived. In playback mode, the data logger writes all the packets back out to the network, using the timestamps to ensure the correct time sequencing.

The plan view display (PVD) console displays a two-dimensional tactical map showing the terrain and icons for all vehicles participating in the exercise. The PVD also provides interfaces for controlling the stealth vehicle and the data logger. The PVD can be used to "teleport" the stealth vehicle to a specified location or to attach it to a specified vehicle, causing it to follow wherever that vehicle goes. The PVD can also be used to direct the data logger to play back an exercise - in real time or faster than real time - or to skip to a specific location in time (rewind, fast forward, search).

Data Analysis

The data analysis system provides the ability to analyze the statistical data recorded by the data logger. These data include packets of information sent to the network as a result of normal interactions among simulation programs during an exercise. These data may also include other types of information sent over the network as a result of explicit "instrumentation" packets of information. Much of the data collected in support of the CVCC software was the result of this explicit instrumentation.

The following statistical measures are available without any special instrumentation:

- number of rounds fired by each combat vehicle

- number of hits scored by each combat vehicle

- average distance between the impact point of a round and the nearest vehicle

- percentage of combat vehicles engaged in combat

- losses of combat vehicles on each side

Additional information packets have been developed and allow recording information related to specific measures of effectiveness. See the section on Instrumentation subprotocol and Loral Advanced Distributed Simulation, 1991d, for more information.

CVCC Utilities

In an experiment, the ability to control conditions and reduce the number of variables is central to obtaining useful data. The CVCC utilities aid the experimenters in setting up the initial conditions of a scenario and controlling the exercise. The CVCC utilities include:

- Send utility
- Listen utility
- Checkpoint utility

The Send utility can be used to batch-load CVCC reports into all CCD and BnTOC workstations participating in an exercise. It provides an easy method for creating a well-defined message context for the initial conditions of an experiment. Alternatively, the Send utility can be used to send CVCC reports in real time. In this mode, the Send utility can act as a stand-in for manned and unmanned vehicles when the emphasis is strictly focused on training soldiers to draw correct conclusions about the current battlefield situation from the flow of Army reports. The Send utility is also used to represent information and reports received from higher or adjacent units.

The Listen utility is useful for checking what command and control information is being sent over the network. The Listen utility simply reads all the packets on the network and prints the contents of any packets that contain command and control information (see the description of the CVCC protocol).

The Checkpoint utility gives the CVCC MWTB a limited capability for exercise control; it defines operations that all participating systems can perform. The operations include creating a checkpoint, deleting a checkpoint, and loading a checkpoint. A checkpoint contains information on the current state of the system. It is useful for saving the initial conditions of an experiment so they can be easily recalled. Checkpoints are also useful for saving the interim conditions when the evaluation must be stopped for any reason and subsequently resumed. Currently, the BnTOC workstations, CCD, and the CVCC simulators participate in the automatic checkpoint utility. While the SAF can be checkpointed by hand, it is not part of the automatic checkpoint utility.

How do the Pieces Work Together?

The software and hardware systems described in the last section are able to participate in the overall simulated world independently of the number and variety of other systems involved. However, these systems require a large amount of information about other entities in the simulated world and a high degree of cooperation and interaction with other entities in order to work properly. These needs are provided through the use of networks and protocols.

The network is the physical medium connecting the various systems participating in the distributed interactive simulation. Local-area and long-haul networks use a number of different physical media, including Ethernet™, dedicated telephone lines, and satellite links, and are joined to form a single logical network.

Each entity participating in the simulated world sends packets of information onto the simulation network. These packets conform to standard formats that constitute what is called a communications protocol. Communications protocols codify the rules and regulations controlling the interaction between the various entities in the simulated battlefield.

This section briefly describes the family of protocols used in the CVCC MWTB to control the interactions between various entities in the simulated world. These protocols include the following:

- simulation protocol
- data collection protocol
- radio simulation protocol
- CVCC protocol

The following sections describe the purpose of each protocol and the software and hardware systems that use it.

Simulation Protocol

The information reported in the simulation protocol includes:

- simulator initialization conditions
- locations and appearances of vehicles
- events related to weapons fire and collisions
- exchange of fuel or ammunition among vehicles
- vehicle malfunctions and repairs

The simulation protocol is used primarily by vehicle simulators to introduce simulated elements into an exercise, remove them from an exercise, and convey information about the simulated world for use by simulators (LADS, 1991d).

Systems in the CVCC MWTB which participate in the simulation protocol include:

- Enhanced M1 tank simulator (with CITV and Autoloader)
- MCC
- SAF
- CCD
- SINCGARS

The simulation protocol is central to the operation of the enhanced M1 tank simulator, the MCC, and the SAF. The enhanced M1 tank simulator, the MCC, and the SAF send simulation protocol packets to communicate the current state of their vehicles including the vehicle location, the vehicle appearance (if the vehicle has a normal appearance, is burning, is generating a dust cloud, etc.), turret orientation, and fuel and ammunition levels, among other information. Similarly, they send simulation protocol packets to communicate the occurrence of discrete events such as weapons firing, munitions detonation, and collisions. The MCC uses the simulation protocol to reconstitute, repair, and resupply simulated vehicles for which this is possible. The enhanced M1 tank reads simulation protocol packets to display the simulated world correctly to their operators in the out-the-window views. The SAF reads simulation protocol packets to update its map display.

CCD and SINCGARS simulators use the simulation protocol in order to integrate properly with the enhanced M1 tank simulator with which they are associated. Both systems read the simulation protocol packets to obtain status and location information about their own vehicles. The CCD uses this information to correctly depict the vehicle on the tactical map display. The SINCGARS radio uses this information about its own vehicle together with information about other vehicles that have radios to do proper propagation modeling..

Data Collection Protocol

The data collection protocol is used to report, via the network, information about the simulated worlds. Whereas the simulation protocol conveys information of interest to simulators, the data collection protocol conveys additional information that is primarily of use to:

- analysts who may be studying an exercise
- systems that must monitor the state of an exercise to restart it or resume it after some interruption

In the CVCC System Architecture, the data collection protocol is used to support the interoperability between the individual systems making up the CVCC tank. The enhanced M1 tank simulator uses the data collection protocol to communicate information about how the Laser Range Finders (LRF) are being used. This information includes which LRF is in use (Gunner or CITV) and whether the LRF has successfully located a target. In addition to being useful to analysts, this information is used by the CCD when filling out reports. The CCD supports entering report locations (such as the location of enemy vehicles in Spot and Contact reports) using the CITV Laser Range Finder.

Radio Simulation Protocol

The information reported in the radio simulation protocol includes:

- the current state of a radio transmitter, including its operating state and what vehicle it is attached to
- signals containing the actual voice or data transmissions

The radio simulation protocol is analogous to the (vehicle) simulation protocol described in the section describing the simulation protocol. It can be thought of as an extension to the simulation protocol to support radio simulations.

In the CVCC MWTB, the SINCGARS radio simulators use the radio simulation protocol and the simulation protocol for SINCGARS-to-SINCGARS transmissions. The SINCGARS simulation uses the state information from the radio simulation protocol to map radios to vehicles. It uses the simulation protocol to determine where those vehicles (and thus the radios) are. With this information, the propagation model in the SINCGARS software is able to determine what radio it should be listening to, and reads the signal information from that radio only, ignoring signals from competing radios (Pope et al., 1990).

CVCC Protocol

The CVCC protocol was developed specifically to support the communication and interaction requirements of the command, control, and communications systems used in the CVCC MWTB. The information reported in the CVCC protocol includes:

- command and control data
- information about current CITV orientation
- information to support transmitting data via the SINCGARS radio
- instrumentation information for data collection purposes
- specialized exercise control functions required by the checkpoint utility

Each class of information serves a different purpose and is used by different software components of the CVCC system. Each of these classes, its users, and its purpose is discussed in the paragraphs that follow.

The primary use of the CVCC protocol is to support the communication of command and control information. This information includes Army reports, graphical overlays, vehicle location information (POSNAV), and vehicle status information, which includes the status of fuel, ammunition, and equipment. The BnTOC workstation, CCD, and SAF use the CVCC protocol to send and, with the exception of SAF, receive this information over the simulation network. When no SINCGARS radio simulation is used, the CVCC protocol is used to transmit command and control information directly between different C3 simulation software components (in SAF, the CCD, and BnTOC workstations).

Part of the CVCC protocol is used by BnTOC and CCD C3 simulation software to access the service provided by SINCGARS radio simulators. When the SINCGARS radio simulators are used, C3 simulation software in the BnTOC workstation and the CCD transmit their command and control information using two SINCGARS simulators as intermediaries. The sending and receiving SINCGARS simulators simulate the relevant effects of radio transmission upon the receipt of this information.

The CVCC protocol supports the interoperability of the enhanced M1 tank simulator and the CCD. The enhanced M1 tank uses the CVCC protocol to communicate information about the current orientation of its CITV. The associated CCD uses this information to correctly depict the tank on its tactical map.

A fourth use of the CVCC protocol is to provide BnTOC-specific and CCD-specific extensions to the data collection protocol without requiring changes to the data collection protocol. This additional information is recorded, along with standard data collection information, by the Data Logger. To provide sufficient data to support the CVCC experiments, the BnTOC workstation and CCD simulation were made to report a wide variety of information about their internal status and how they are being used by the operator. The CVCC protocol supports the communication of this "instrumentation" information.

Finally, the CVCC protocol is used to coordinate the operation of BnTOC workstations, CCDs (and attached vehicles), and SAF. This portion of the protocol is initiated by a BnTOC workstation running with the "coordinator" option. With this option active, the BnTOC workstation also functions in the capacity of a manager (or coordinator) for CVCC applications. The BnTOC workstation, CCD, and SAF applications respond to this portion of the protocol. The CVCC tank simulator is a second-order participant, responding to directions from its associated CCD. The functions supported by this portion of the protocol include checkpointing (creating, deleting, and loading) and shutting down CVCC applications.

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CVCC HARDWARE AND SOFTWARE ARCHITECTURE

This section provides a more detailed description of the hardware and software architecture of the simulations developed specifically for the CVCC program. These simulations include the enhanced M1 simulation (CITV and Autoloader), SINCGARS radio, CCD, and the BnTOC workstation. CCD and the BnTOC workstation are presented together because they share many of the same functional capabilities.

Enhanced M1 Tank Simulator

The Enhanced M1 Tank Simulator used by the CVCC Simulation is implemented using a SIMNET M1 tank simulator as a base. Historically, the SIMNET M1 simulator used the MASSCOMP™ 5600 as a simulation host processor and a BBN 120T™ Computer Image Generator (CIG). The delivery platform was then upgraded to the dual-processor GT101™, which eliminated the need for a separate simulation host computer. The GT101 was the standard delivery hardware for the M1 simulator at the start of the CVCC program. The Enhanced M1 Tank Simulator is based on the GT101 version of the M1 tank simulator, with additional enhancements to both the hardware and software, including the use of a GT111™, as will be described below.

Functionally, the Enhanced M1 Tank Simulator differs from the baseline M1 tank simulator by the addition of a high-resolution thermal viewer with CITV capabilities and integration of the Autoloader functionality. The ammo capacity of the simulators was also modified. The Enhanced M1 Tank Simulator has a full load of 40 main gun rounds (in CVCC formative evaluations this consisted of 27 rounds of APDS and 13 rounds of HEAT).

Hardware

Figure 6 depicts the top level hardware architecture of the Enhanced M1 Tank Simulator. The GT111 is a dual processor computer using Motorola® MVME147 boards. The main processor hosts the Computer Image Generator (CIG). The second MVME147 board hosts the Enhanced M1 Tank Simulator software.

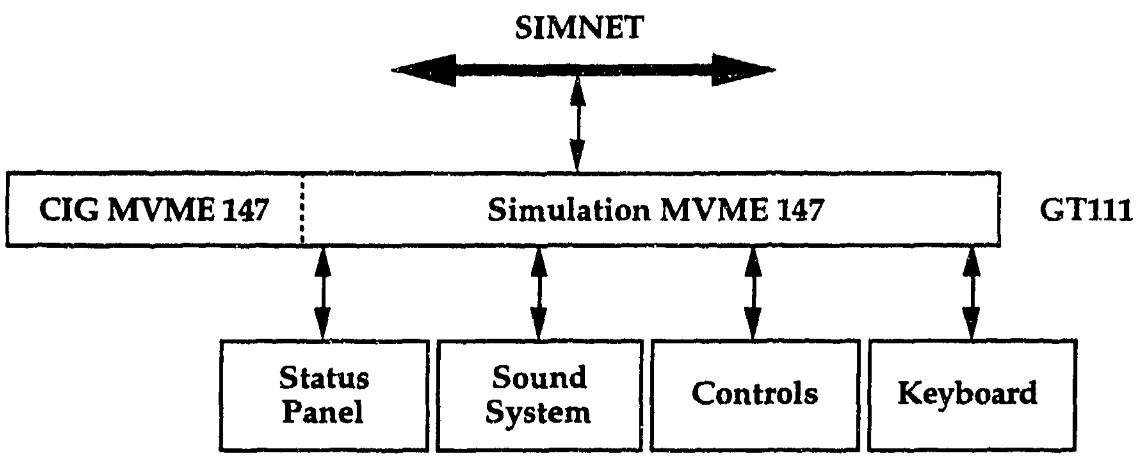

Figure 6. Hardware architecture for Enhanced M1 Tank Simulator.

The GT111 drives the network interface via an Ethernet™ driver aboard the host processor's MVME147 card. Additionally, the GT111 is connected to the hardware components for the Status Panel, Sound System, Controls, and Keyboard. The Status Panel monitors the simulator hardware components and provides an indication of their failure. The hardware interface between the simulation and the Status Panel is through the Burr Brown® MP830-72 TTL I/O card. The Sound System is used to provide aural cues to the crew of the simulator and is connected via an RS-232 line. The Controls provide the crew interface to the vehicle simulation in the form of toggles, buttons, meters, etc, and are connected via an RS-232 line to IDC boards which provide a shared memory interface. The Keyboard is used during development and debugging of the vehicle simulator.

The notable difference between the GT101 and GT111 is that the GT111 generates a high-resolution view. The Enhanced M1 Tank Simulator uses this view to drive the CITV display. The remaining hardware components will not be described in greater detail in this document since, aside from the adoption of the GT111, the hardware architecture is described in other documents (Culviner et al, 1993; Loral Advanced Distributed Simulation, 1991a; Loral Advanced Distributed Simulation, 1991b; and Loral Advanced Distributed Simulation, 1991c).

Software

The top level software architecture of the Enhanced M1 Tank Simulator is the same as the standard SIMNET M1 software architecture and depicted in Figure 7.

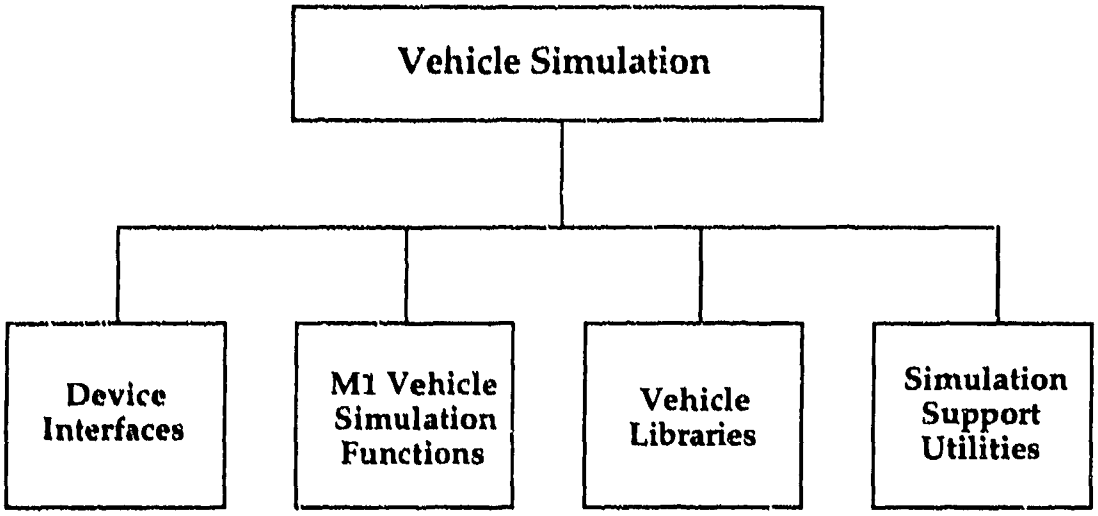

Figure 7. Software architecture for Enhanced M1 Tank Simulator.

The Device Interfaces module handles communications between the simulation processor and a number of different devices, including the CIG, SIMNET LAN, sound system, status panel, controls, and keyboard. The Vehicle Simulation Functions module performs the actual simulation of tank functions and its processing of input and output. These functions include modeling hull and turret, vehicle dynamics, failures, and weapons as well as interaction with controls, lights, meters, and the simulation network. The Vehicle Libraries module provides generic functions useful for the simulation of any kind of vehicle. The Simulation Support Utilities module provides generic functions useful for any software module.

Adding the CITV functionality of the Enhanced M1 Tank Simulator primarily affected the Vehicle Simulation Functions module, where the additional capabilities of the CITV are located, but required supporting modifications within all top level software modules. The Autoloader capability required support within the Vehicle Simulation Functions module and modification to the Device Interfaces module. The Device Interfaces module was modified to simulate the presence of a loader, who had pressed the appropriate buttons at the appropriate times.

Since the software architecture of the Enhanced M1 Tank Simulator is the same as the baseline M1 software architecture, and is documented in chapter 2 of the Top-Level

Descriptions for SIMNET Software, it will not be described in greater detail in this document (see Loral Advanced Distributed Simulation, 1990).

SINCGARS Simulation

SINCGARS Hardware Architecture

The vehicle version of the SINCGARS simulator in the CVCC MWTB is complicated by the presence of an internal intercom system and multiple radios. This makes the diagram and description of the hardware architecture more complicated without adding any fundamental understanding. Therefore, for the sake of simplicity, this section concentrates on the table-top module of the SINCGARS simulator.

Figure 8 shows that the SINCGARS simulator hardware is physically divided into two parts: the table-top radio box and the host computer. The simulator hardware has an interface from the host computer to the real hardware, including real SINCGARS radios. The table-top radio box constitutes the user interface to the radio simulator. The host computer contains the radio simulation software. Currently, the host computer in the CVCC MWTB is a MASSCOMP 6600.

The SINCGARS radio simulator has the following I/O subsystems:

- controls I/O subsystem
- speech I/O subsystem
- Ethernet subsystem
- real-world interface subsystem

The controls subsystem has a front panel display and hard controls that implement the radio settings (channels, frequency settings, operation modes, push-to-talk switch, etc.) in the table-top radio box. The Front Panel Adapter (FPA) and the Interaction Device Controller (IDC) detect when the user manipulates the controls and send signals over RS-232 lines to the radio simulation software, causing the radio simulation to change its behavior (and in some instances the appearance of the front panel controls) appropriately.

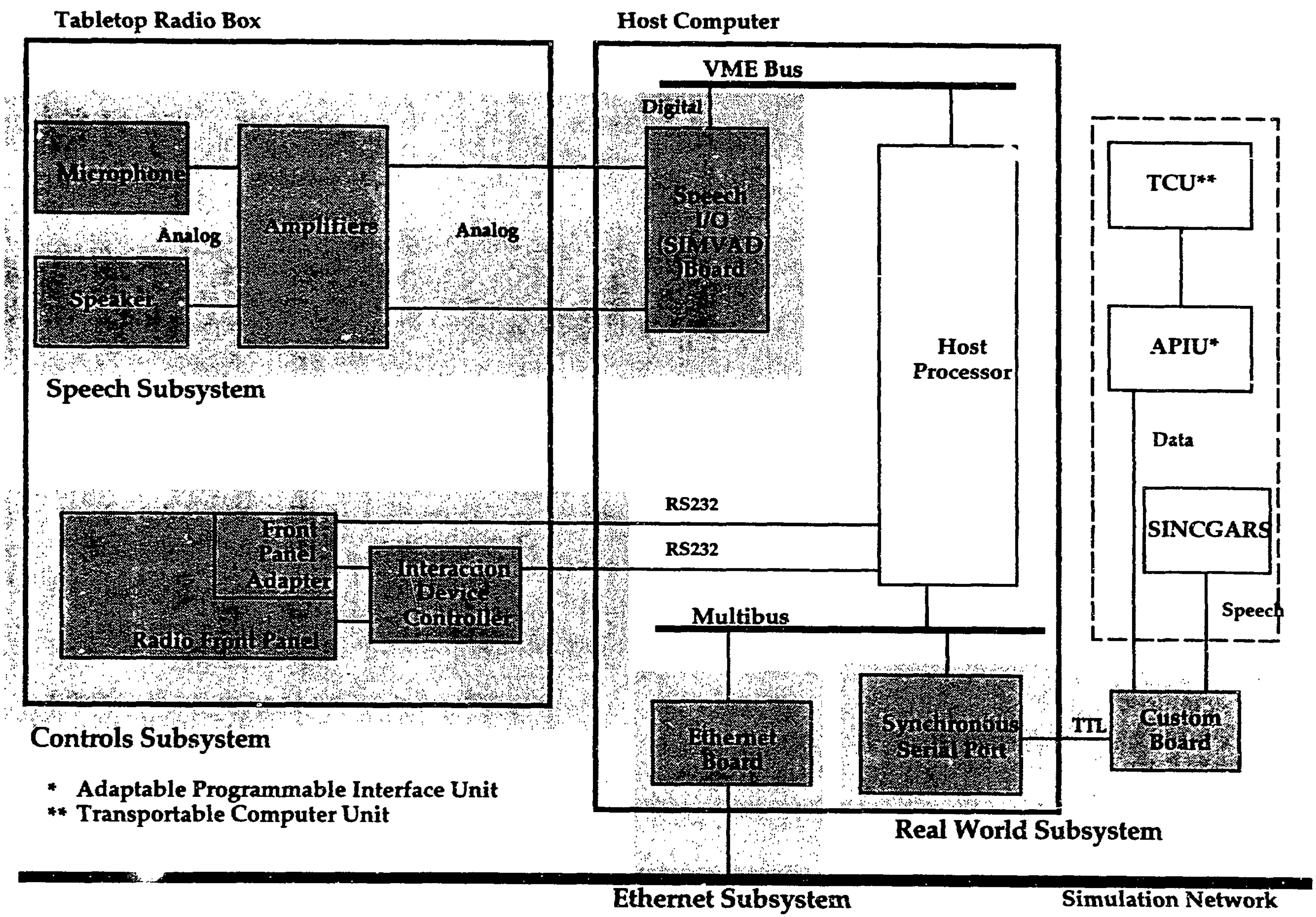

Figure 8. SINCGARS radio simulation hardware architecture.

The speech subsystem includes a microphone and a speaker in the table-top radio box. These are the analog input and output devices for speech transmissions. The analog signals pass through amplifiers to the speech I/O board in the host computer. The speech I/O (SIMVAD) board converts the voice signals from analog to digital (and from digital to analog) form on their way to (and from) the simulation software running on the host processor. To accomplish this, the voice I/O board has A/D (and D/A) converters and a processor to compress (decompress) the digitized speech for more efficient transmission. The digitized and compressed speech is then passed to the radio simulation software running on the host processor (CPU). Depending on the current state of the radio as defined by the radio simulation software, the digitized speech may be transmitted to the other SINCGARS radio simulations via the Ethernet subsystem or to real SINCGARS radios via the real-world interface subsystem.

The Ethernet subsystem consists simply of an Ethernet board connecting the host computer to the simulation network Ethernet.

The real-world interface subsystem includes a synchronous serial port in the host computer, connected to a custom board. The custom board passes the voice signal to the real SINCGARS radio, where it can be transmitted to other real SINCGARS radios. In this way, soldiers sitting at a SINCGARS radio simulator in the CVCC MWTB can communicate directly with soldiers sitting at a real SINCGARS radio in a real tank. In addition, the custom board can pass data transmissions to the Transportable Computer Unit (TCU) and the Adaptable Programmable Interface Unit (APIU), which are real-world devices for data communications.

SINCGARS Software Architecture

In a CVCC-equipped tank, communications are provided by three separate pieces of hardware. Two SINCGARS radios provide for the basic voice communications. Data communication is mediated by an intelligent controller, called a Radio Interface Unit (RIU), that is connected to both radios. The RIU formats and queues data for transmission on radio channels, performs error checking and correction of received data, and implements schemes for addressing, routing, and network management. The RIUs of the various vehicles participating in a single combat radio network behave as packet-switching nodes to provide, collectively, a dynamic, mobile data network for communication among vehicles. Some RIUs may also serve as bridges or gateways, linking two or more combat radio networks to permit communication among vehicles on distinct networks.

In the SINCGARS radio simulation, a single process simulates multiple RIUs and the radios with which they are associated. The total number of RIUs and radios that can be simulated by one host computer is limited only by the computational power of the host. The effective limit of the MASSCOMP 6600 used in the CVCC MWTB is four RIUs and six SINCGARS radios. Thus, one host computer can support up to three CVCC tank simulations, each of which has 2 SINCGARS radios. A single process running on the host computer simulates all the RIUs and all the radios simultaneously.

The SINCGARS radio simulation software is divided into six modules, or Computer Software Components (CSCs). Three of these CSCs - the network I/O interface, the front panel control interface, and the speech I/O interface - maintain interfaces to three of the I/O hardware subsystems mentioned in the section describing the SINCGARS hardware architecture - the controls subsystem, the speech subsystem, and the Ethernet subsystem. The other three CSCs - the radio model, the propagation model, and the RIU - implement the major functional capabilities of the SINCGARS radio. Figure 9 shows a block diagram of the SINCGARS radio simulation and software architecture.

The network interface monitors all network traffic. It retrieves radio simulation PDUs, simulation PDUs, and CVCC PDUs, passing them on to other models via the communications module.

The front panel control interface samples all the front panel controls relevant to the communications system, and then passes their state to the radio model. Typical parameters include push-to-talk button status, frequency selection, hopset selection, and radio/intercom select switch position. In addition, the front panel interface feeds back changes to the front panel controls from the radio model.

The speech I/O interface controls the flow of digitized speech between the speech subsystem and the radio model.

The radio model uses the radio simulation protocol to effect voice communications between radio simulations.

The propagation model adds realism to radio communications by simulating effects such as terrain obstruction, distance attenuation, weather, and soil conditions.

The propagation model includes a simplified terrain database used to determine terrain interference.

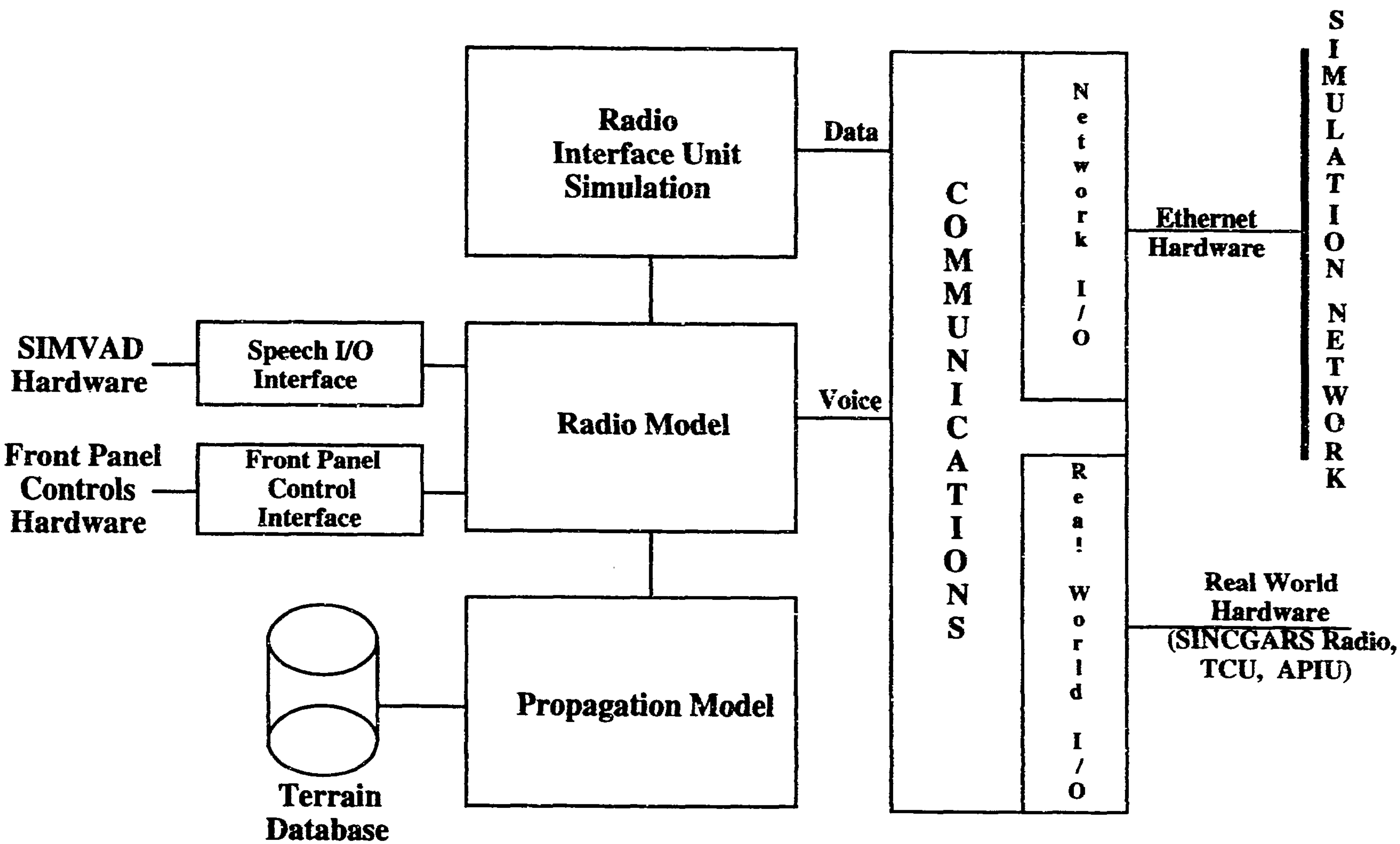

Figure 9. SINCGARS radio simulation software architecture.

The Radio Interface Unit (RIU) simulation provides the CCD with an interface to the SINCGARS radio for transmitting and receiving data. It performs error correction on data corrupted by the radio simulation. Finally, it plays the role of a multiplexer for sending both voice and data using a single SINCGARS radio. It does this by giving priority to voice transmissions (see National Technical Information Agency; Ford Aerospace and Communications Corp., 1986; Pope et al., 1990; and U.S. Army, 1986).

SINCGARS Data Flow

This section describes the path that voice traverses through a simulator when it is sent and when it is received. The first part describes the path of voice through the SINCGARS simulator. It includes the different formats that the voice data takes as it passes through the various software and hardware modules. The second part provides an analogous description of the path of data from the CCD simulation.

Voice Flow Through the SINCGARS Radio Simulator

Voice begins its trip through the SINCGARS simulator when a radio operator keys the push-to-talk switch on the table-top radio microphone. This sends a signal through the IDC board to the radio simulation software on the host computer. The radio simulation software starts sampling the appropriate SIMVAD board for the speech signals. As the operator speaks into the microphone in the table-top radio, an analog speech signal is sent through the amplifier to the SIMVAD board, where it is digitized and compressed. The digitized and compressed speech is passed to the radio simulation software, which packs it into Signal PDUs (of the radio simulation protocol) along with information about the current state of the local radio (frequency, hopset, mode, etc.). These are passed to the Ethernet interface, which broadcasts the speech signals onto the simulation network.

Meanwhile, other SINCGARS radios on the simulation network are listening for Signal PDUs on the simulation network. These PDUs are picked up by the Ethernet interface and passed to the radio simulation, which consults the propagation model to determine whether any of the local radios can hear the transmitter. If appropriate, the digitized and compressed speech signal is passed to the speech I/O subsystem. The SIMVAD board decompresses the speech signal and converts it from digital to analog format before passing it on to the amplifiers and the speaker, where it can be heard by the listener.

Data Flow Through the SINCGARS RIU Simulator

The SINCGARS simulator is not capable of generating data to be transmitted. It merely serves as the medium by which data are communicated between simulators such as CCD, which are capable of generating data.

Data generated by a CCD simulator are packaged into Transmit Request PDUs and broadcast on the simulation network. The SINCGARS simulator belonging to the same vehicle as the CCD simulator picks up the Transmit Request PDUs at the Ethernet interface and passes them to the RIU simulation. The RIU simulation resends the data to the simulation network using the RIU-to-RIU unreliable broadcast protocol.

Meanwhile, other SINCGARS simulators are listening for the RIU PDUs. The RIU PDUs are picked up at the Ethernet interface and sent to the RIU simulation. If the RIU is using the same command net as the originator, the data are copied into a Receive PDU and rebroadcast on the simulation network. The Receive PDU is then picked up by the CCD associated with this RIU and the data are passed to the appropriate modules in the CCD simulator. See the section describing Data communications with SINCGARS for a more complete description of the CVCC Protocols which supports this process. Figure 10 shows this data flow.

BnTOC Workstation and CCD Simulations

This section describes the hardware and software architecture of the BnTOC workstation and CCD simulations. They are considered here together because they share many of the same functional capabilities and software modules. The section begins with a discussion of the hardware architecture for each simulation. Then the software architecture and capabilities are described, first for the shared modules, then for the modules that are specific to the BnTOC workstation simulation, next for the modules that are specific to the CCD simulation, and finally for modules that are partially duplicated in the two simulations.

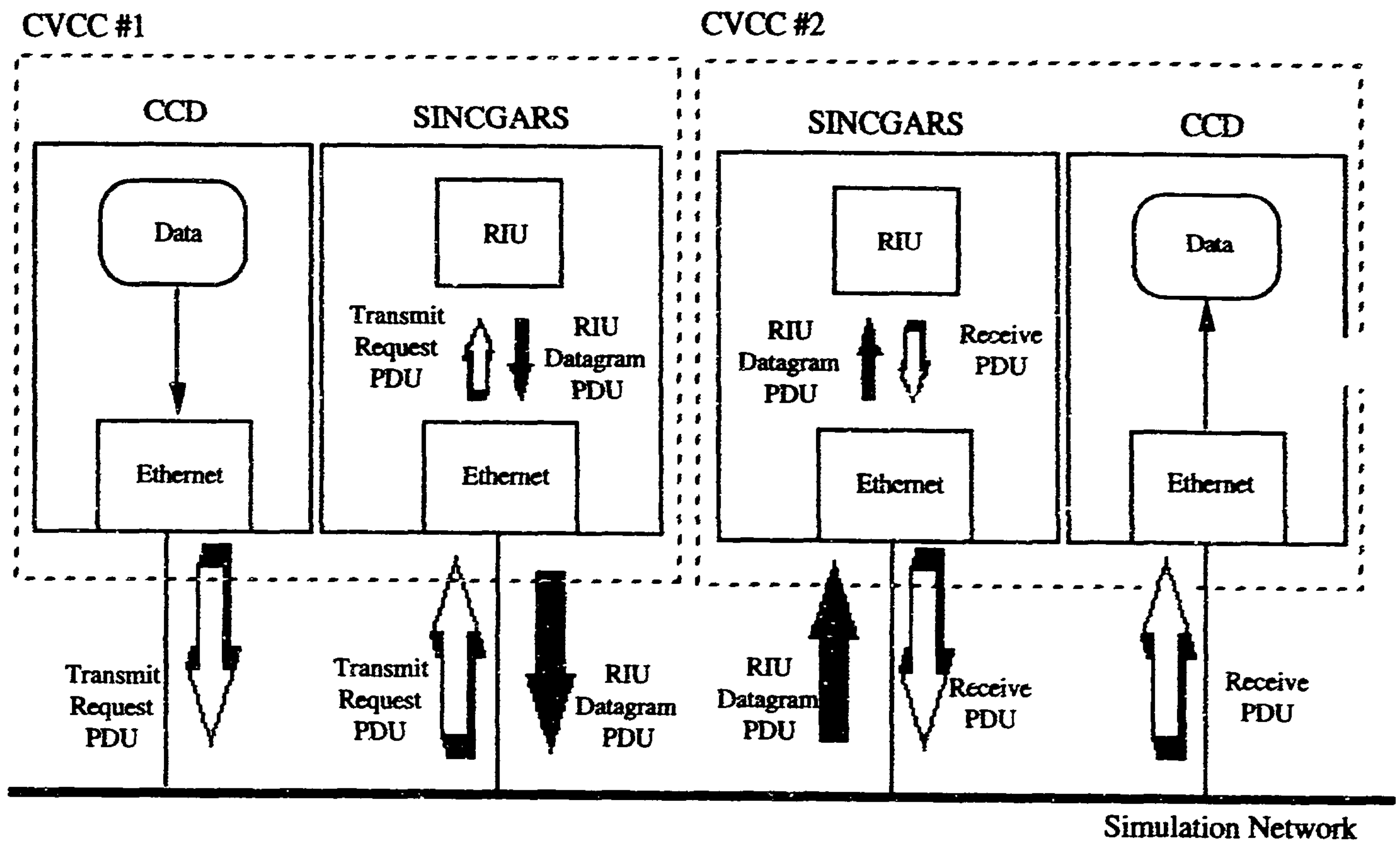

Figure 10. Data communications using SINCGARS.

BnTOC Workstation Hardware Architecture

The BnTOC workstation runs on the Sun SPARC® family of processors (see Figure 11), specifically, the SPARC 1 and the SPARC IPX. BnTOC is divided into the host processor and two major subsystems. These systems are connected to the host processor via a bus network (the network carrying signals between the subsystems in one workstation). The subsystems are:

- I/O subsystem
- Ethernet subsystem

The I/O subsystem supports the user interface. It consists of a three-button optical mouse, a keyboard, and two video heads. The mouse and the keyboard are input devices for interacting with the application. The mouse is used to position the cursor in the graphical user interface (GUI), and the keyboard is used to input text. The video heads are the output devices used to display the user interface. Each video head consists of a 19-inch, color CRT monitor and a frame buffer video driver. The monitors have a resolution of 1152 x 900 pixels, and the frame buffers support 8-bit pseudo color. This means that at any time, 256 colors are available from a total of 2**24 (approximately 4 million) possible colors. One of the video heads (usually the left one) is dedicated to displaying the tactical map. The second video head displays the rest of the BnTOC workstation's user interface. Although the BnTOC workstation is designed to run on a two-headed host, it is capable of running on a single-headed host as well.

The Ethernet subsystem is an Ethernet board that connects the BnTOC simulation directly to the simulation network. The BnTOC listens directly to the simulation network for packets. The BnTOC hosts contain a software driver for reading simulation packets. Each BnTOC application determines which packets it needs and throws away the rest.

CCD Hardware Architecture

The CCD simulation runs on the Sun SPARC family of processors (see Figure 12), specifically, the SPARC IPX. The CCD is divided into the the host processor and three major subsystems:

- commander's I/O subsystem
- driver's I/O subsystem

* Ethernet subsystem

The commander's I/O subsystem consists of a single video head, a touch screen, and a thumb controller on the commander's control handle. The video head is the output device for the application. It consists of a CRT monitor, which is part of the CCD in the commander's station, and a frame buffer video board in the host computer. The monitor is a 13-inch, high-resolution (1250 x 1024 pixels) color monitor. The frame buffer is the same as the ones used in the BnTOC workstation.

The touch screen and thumb controller are used in place of an optical mouse for interacting with the simulation's GUI. The touch screen is a pressure-sensitive touch screen from Elographics. When the screen registers a touch, it starts sending analog signals to a board that converts them to a digital signal. This board interfaces to the host computer over a serial RS-232 connection. The digital output is picked up by the CCD software and used to move the cursor. Since the touch screen is used in place of a mouse input device, touching the screen and removing one's touch from the screen have the same effect as pressing and releasing a mouse button.

The thumb controller is mounted on the commander's control handle. It is a variable resistance button that operates in three planes of motion. Moving the button to the left and right (X direction), and up and down (Y direction) controls the cursor on the video display. Pushing the button has the same effect as clicking on a mouse button. Operating the thumb controller causes an analog signal to be sent to an Analog to Digital/Digital to Analog Converter (known as an ADDA board) in the host computer. The ADDA board samples the analog connection at least 5 times a second and converts the analog signal to digital form. The CCD software on the host processor reads this digital output, using it to drive the cursor on the video display.

The driver's I/O subsystem consists of the soft panel in the driver's compartment, a PC that drives the soft panel, and an RS-232 connection from the PC to the host computer. The CCD application sends information about where the driver must go next over the RS-232 connection. The PC interprets this information and displays it on the soft panel in the driver's compartment.

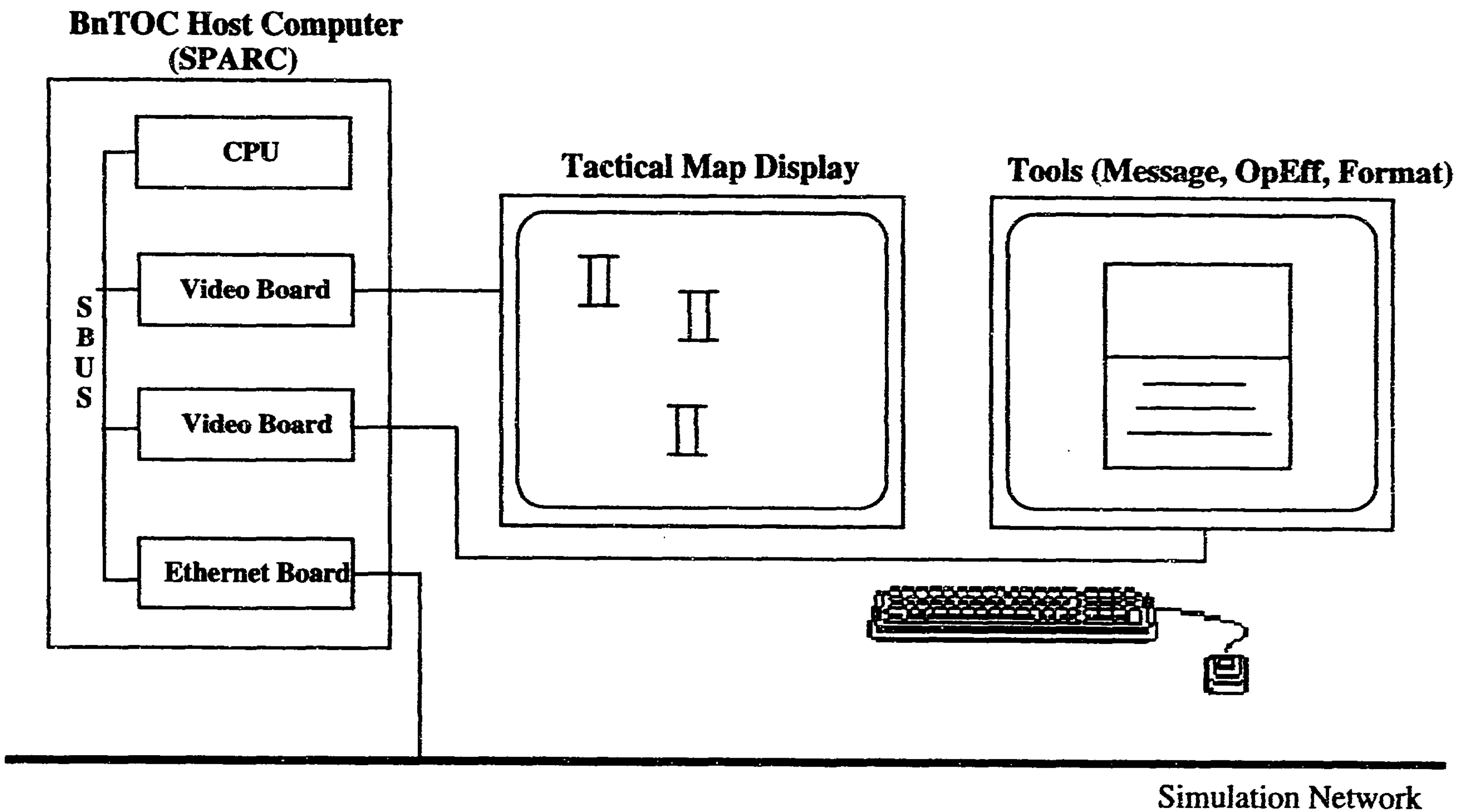

Figure 11. BnTOC workstation hardware architecture.

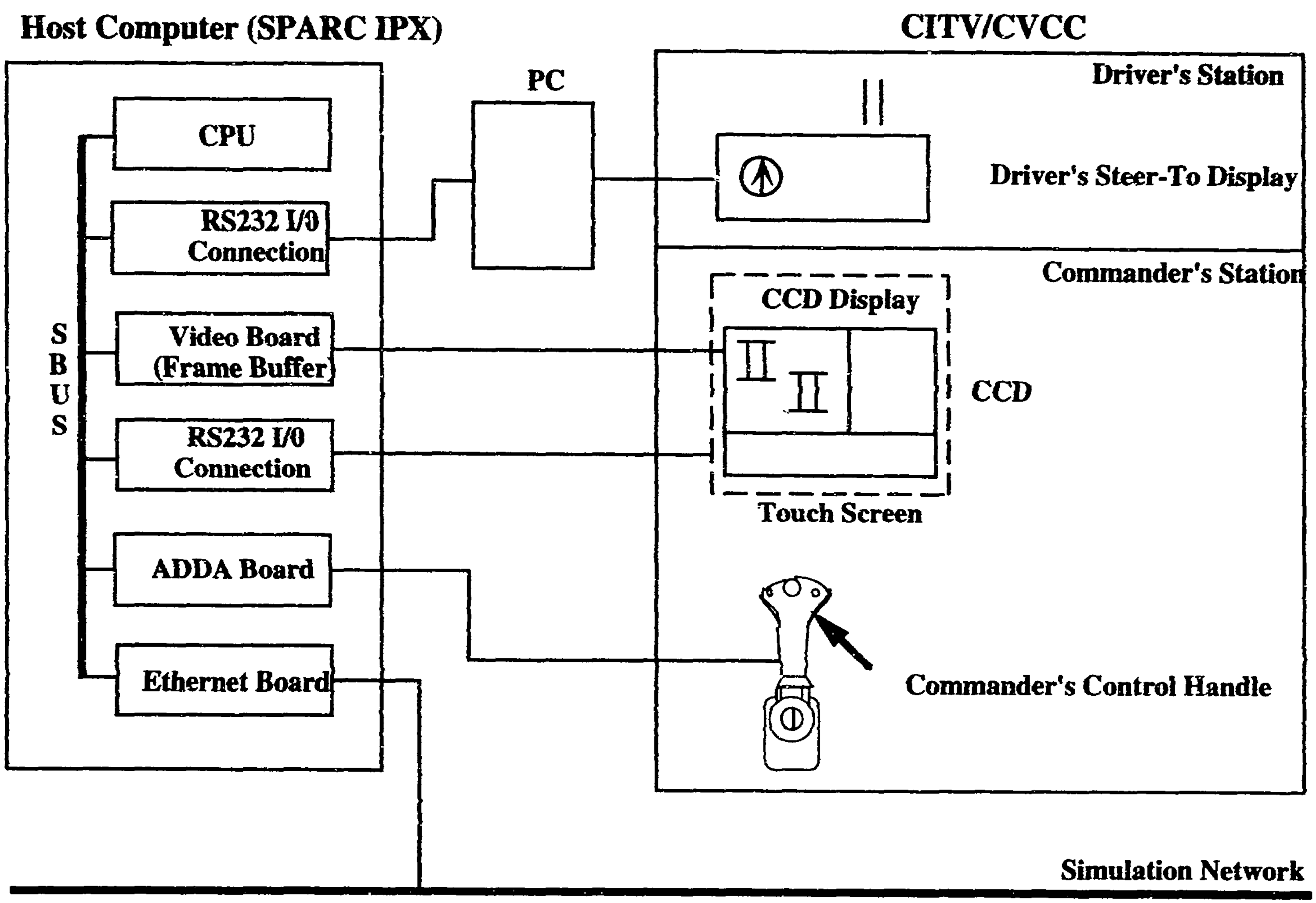

Figure 12. CCD simulation hardware architecture.

The Ethernet subsystem is an Ethernet board that connects the CCD simulation directly to the simulation network. The CCD listens directly to the simulation network for packets. The CCD hosts contain a software driver for reading simulation packets. Each CCD application determines which packets it needs and throws away the rest.

BnTOC Workstation and CCD Software Architecture and Capabilities

This section describes the architecture and functional capabilities of the BnTOC Workstation and the CCD simulation software. The BnTOC and the CCD simulations share a common software architecture and many of the same software modules. In this way, the two systems provide a similar set of functional capabilities while minimizing the amount of software required. The modules in this architecture can be divided into the following four categories:

- shared – modules used by both systems. The shared modules constitute approximately 60% of the total lines of code in the two systems and provide approximately 75% of the functional capabilities. They include the following:

  * Map Module
  * Vehicle Status Module
  * Task Organization and Operational Effectiveness (TOOE) Module
  * Position Navigation (POSNAV) Module
  * Report Module
  * Fire Support Module
  * Exercise Control Module
  * Configuration Module
  * Communications Module

  Some shared modules have extended capabilities that are available in only one of the systems. For example, the concept-of-operations capabilities of the Overlay Module are available only in the BnTOC Workstation. Similarly, the Own Vehicle Status Submodule of the Vehicle Status Module is an extension used only by CCD. Also, although the Navigation Module depends heavily on the shared capabilities of the Report Module, the Navigation Module itself is used only by CCD.

- BnTOC-specific -- modules that provide capabilities unique to the BnTOC Workstation. These include the following:

  * Concept-of-Operations extension to the Overlay Module

  * Format Module

- CCD-specific - modules that provide capabilities unique to the CCD simulation. These include the following:

  * Own Vehicle Status Submodule of the Vehicle Status Module

  * Navigation Module

- Duplicated - modules that provide similar, but not identical capabilities, and are therefore used in slightly different form in each application. The duplicated modules include the following:

  * Instrumentation Module

  * User interface

The following four sections describe the modules in each of the above categories. For the shared modules, differences between the BnTOC and CCD capabilities are noted in parentheses. For the duplicated modules, comparisons are drawn between the BnTOC and CCD implementations.

Shared Modules

Map module.

The Map Module provides the BnTOC workstations and the CCD simulators with the ability to display and manipulate a two-dimensional map of the battlefield. Elements of the tactical map include terrain features, graphical overlays, report icons, and friendly vehicle (POSNAV) icons. Operations that can be performed on the map include posting and unposting map elements, scrolling the map, and scaling the map. These elements and operations are described below.

- Terrain features - The tactical map can display contour lines, grid lines, rivers, roads, and vegetation. The user can display or suppress display of individual terrain features. These terrain features are described in the terrain database. The terrain database most commonly used by the CVCC software corresponds to a 50 x 75 kilometer region around Ft. Knox, Kentucky.

- Graphical overlays – The tactical map can display graphical overlays such as Operations, Enemy Situation and Fire Support Overlays, which are composed of symbols defined in FM 101-5-1 Operational Terms and Symbols (U.S. Army, 1985). These overlays are arranged in a stack The stacking order can be rearranged by using the stacking commands. The overlays can be edited (BnTOC only), sent to other simulators, and received from other simulators (CCD only). (See the section describing the Overlay Module for more information.)

- Report icons – The tactical map can display icons relating to standard Army reports such as Spot reports and Contact reports. The user can view the associated reports by selecting the report icons. (See the section describing the Report Module for more information.)

- Friendly vehicle (POSNAV) icons – The tactical map can display and update friendly vehicle icons based on the POSitional NAVigation (POSNAV) information received from operational CCDs. To show the current location of the battalion's combat vehicles, these POSNAV icons can be aggregated and de-aggregated to any level of aggregation, from individual vehicles to the entire battalion. (See the section describing the Position Navigation Module for an explanation of the center-of-mass algorithm used to aggregate.)

- Scrolling – The user can scroll the tactical map to any location on the terrain database.

- Scaling – The user can display the tactical map at the following map scales: 1:250,000; 1:125,000; 1:50,000; 1:25,000.

The Map Module is also used to implement the electronic Situation Display in the Battalion TOC area. The Situation Display is a special tactical map that serves as a central planning tool. It is connected to a large-screen monitor so that everyone in the TOC can observe it. All other TOC workstations can post and unpost their own overlays and report icons to the Situation Display. All CCD-equipped vehicle locations are displayed in real time here as well.

The Map Module architecture consists of the following submodules (see Figure 13):

- Color System Submodule – provides the primitives for controlling which colors are used for which features and symbols on the tactical map display. The Color System uses a technique known as "bit planes," which limits the number of colors available for drawing in order to establish two independent and overlapping drawing planes. This allows the Map Module to alter the contents of one of the planes without disturbing the contents of the other. The Map Module dedicates the bottom plane for use by the Terrain Library (terrain features) and the top plane for use by the Symbol Library (overlays, report icons, and POSNAV icons). In this way, the need to redraw the map is minimized at the cost of significantly limiting the number of colors available.

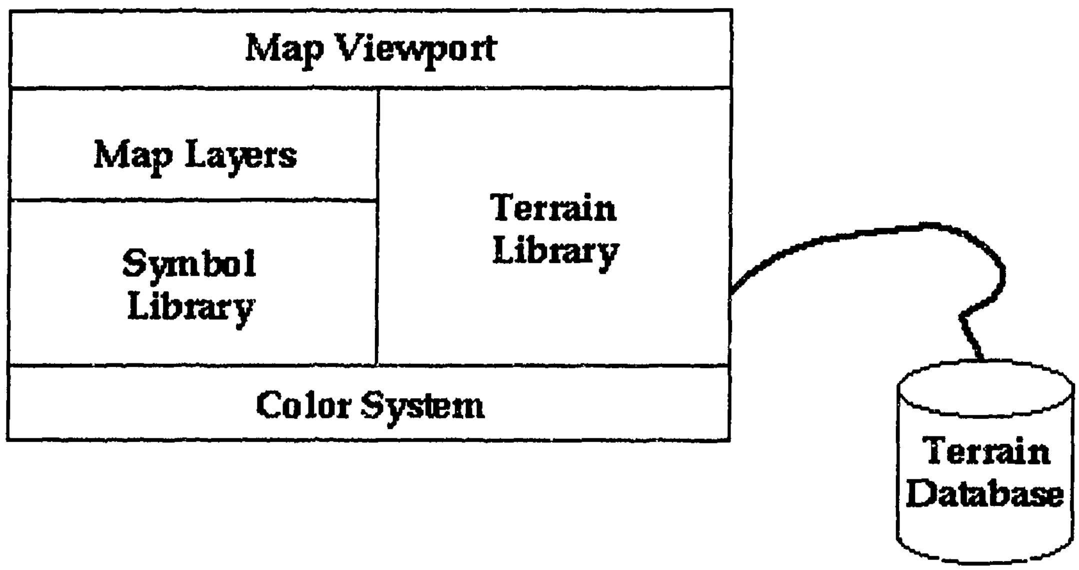

Figure 13. Map module.

The use of colors in the Color System Submodule has been parameterized in order to facilitate reconfiguring the system. The features which have been parameterized are listed in Table 1 together with their default values:

Table 1

Terrain Library Features

Terrain	Default Color
Terrain background	Wheat
Buildings	Black
Fordable water	SkyBlue
Non-fordable water	Blue
Roads	Red
Vegetation	ForestGreen
Low contour lines	Black
High contour lines	Black
Grid lines	Black

The colors used by the Color System Submodule may be configured by the user in the "Bntoc" or "CCD" *xresource* file. The available list of named colors to which the features may be set is located in the file */usr/openwin/lib/rgb.txt* (use the capitalized names). The default settings can be overridden at runtime using the parameters summarized in Table 3 in Appendix C.

- Terrain Library Submodule — provides the capabilities for drawing the terrain features (grid lines, contour lines, roads, rivers, and vegetation) on the tactical map. The Terrain Library reads information about the terrain features from a specially formatted (object-oriented, quad-tree) database that is prepared from Level I Defense Mapping Agency (DMA) data (see the section describing terrain databases). The information read from the "terrain database" is drawn on the tactical map using the terrain plane of the Color System submodule.
- Symbol Library Submodule – provides the primitives needed by the Map Module to draw overlays, POSNAV icons, and

report icons. The Symbol Library Submodule provides the primitives for drawing a large subset of the symbols defined in FM 101-5-1 Operational Terms and Symbols, including control measures (such as phase lines, front lines of troops (FLOT), and restrictive fire areas), unit symbols (such as armored units and mechanized infantry units), and point symbols (such as waypoints, control points, and target reference points (TRPs)). In addition, the Symbol Library Submodule provides the primitives for drawing the symbols used in standard Army reports (such as target locations and observer locations).

- Map Layers Submodule – groups the symbols (POSNAV icons, report icons, and overlay symbols) in the Symbol Library's drawing plane into a stack of layers. It forms the basis of the overlay stacking capabilities, since the Map Module places each overlay displayed on the map in a separate layer. The Map Layers Submodule controls what layers are sensitive to direct manipulation by the user, thus controlling which overlay on the tactical map can be edited in edit mode. (Note that overlays can only be edited in the BnTOC workstation.) The Map Module places the POSNAV icons and the report icons in two special-purpose layers at the bottom of the stack of layers.

- Map Viewport Submodule – maintains a "window-on-the-world" view of the terrain. It provides the scrolling and scaling capabilities required to manipulate this view.

Overlay module.

The Overlay Module enables the user to perform the following operations on the graphical overlays on the tactical map:

- Edit (BnTOC Workstation only) – The user can edit graphical overlays such as Operations and Fire Support Overlays, which are composed of symbols defined in FM 101-5-1 Operational Terms and Symbols.

- Send – The user at each BnTOC Workstation can send overlays to the CCDs and copy overlays from any of the other BnTOC Workstations on the BnTOC network. The CCDs can also forward overlays to each other.

- Receive – The CCDs can receive overlays from all BnTOC workstations and from other CCDs.

- Copy – The user at each BnTOC Workstation can copy overlays from any of the other BnTOC Workstations on the BnTOC network.

- Post – The user can post overlays to and unpost overlays from the tactical map. The user can post any number of overlays simultaneously. BnTOC users have the additional capability of posting overlays to and unposting overlays from the Situation Display. The user at each BnTOC Workstation can view and copy formats from any of the other BnTOC Workstations on the BnTOC network.

The architecture of the Overlay Module consists of one submodule (see Figure 14):

- Overlay Manipulation Submodule – implements the capabilities listed above.

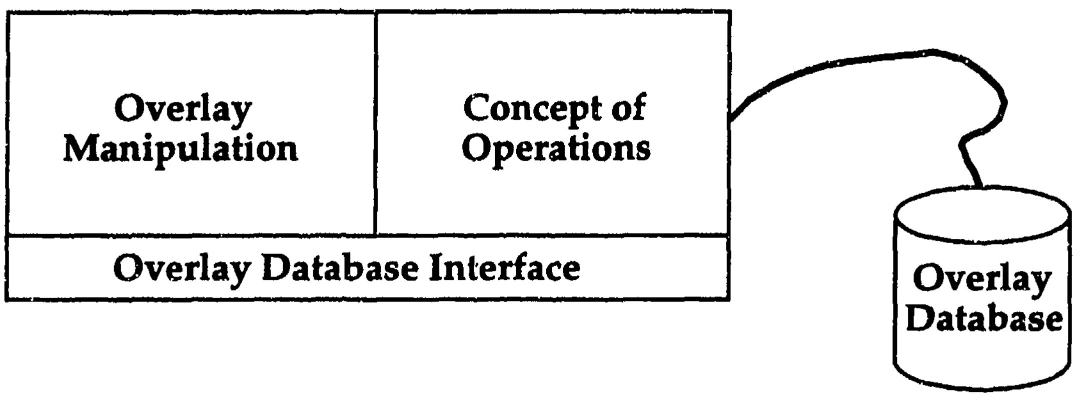

Figure 14. Overlay and Concept-of-Operations module.

<u>Vehicle Status module</u>.

The Vehicle Status module handles all aspects of vehicle status information, including sending own vehicle status, forwarding the status of other vehicles, receiving the status of other vehicles, and dispatching this status information to the appropriate modules for processing. This vehicle status information includes POSNAV information (vehicle location) and operational effectiveness information (status of ammunition, equipment, fuel, and personnel).

The Vehicle Status Module architecture consists of two submodules (see Figure 15).

* Aggregate Status Submodule – dispatches vehicle status data from the Communications Module to the correct modules for processing. Operational effectiveness information about fuel, ammunition, equipment, and personnel is sent to the Task Organization and Operational Effectiveness Module, whereas POSNAV data are sent to the Position Navigation Module. In CCD simulators, the Aggregate Status Submodule sends its own vehicle's location and operational effectiveness status to other CCD simulators on its command network. In CCD simulators playing the role of a unit leader (i.e., Company CO, Company XO, Platoon Leader, or Platoon Sergeant), the Aggregate Status Submodule forwards the status of the vehicles in its unit to its superior command network. Likewise, it forwards vehicle status information found on its superior command network down to the vehicles in its own command network. In this way, each vehicle in the CVCC armor battalion is kept informed about every other vehicle in the battalion.

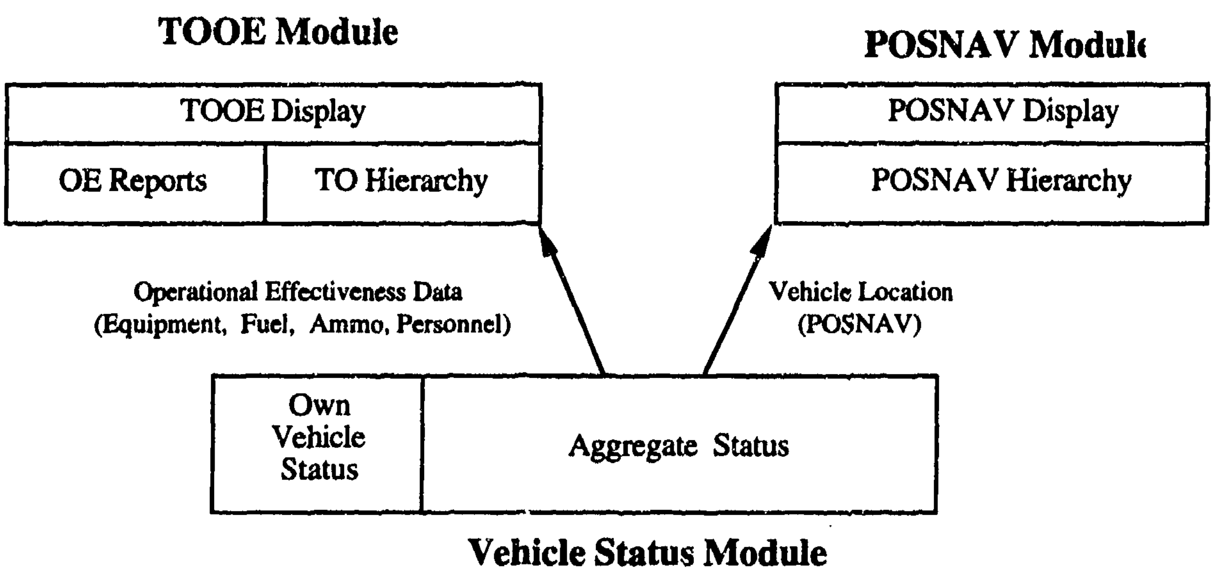

Figure 15. Task Organization/Operational Effectiveness, POSNAV, and Vehicle Status modules.

<u>Task Organization and Operational Effectiveness (TOOE) module</u>.

The Task Organization and Operational Effectiveness (TOOE) Module enables the user to display the current operational effectiveness status of the vehicles in the CVCC armor battalion. The TOOE defines the task organization hierarchy for the CVCC armor battalion and keeps an updated accounting of the operational effectiveness of vehicles and units in the battalion, including the status of ammunition, equipment, fuel, and personnel. This status is continually updated using status reports received from the CCD simulators in the individual tanks. The operational effectiveness status can be displayed to any level of aggregation, from individual vehicles to the entire armor battalion, based on the task organization. The status is displayed in bar-graph format and in the ammunition, equipment, fuel, and personnel circle chart format shown in FM 101-5-1 and the effectiveness levels are color-coded green, yellow, red, and black. Personnel is a placeholder and is currently always green.

The TOOE module architecture consists of three submodules (see Figure 15).

- Task Organization (TO) Hierarchy Submodule - maintains the task organization of the CVCC armor battalion in the form of a tree structure (an organizational chart) that captures superior/subordinate reporting relationships, as well as unit and subunit composition. This information is read into the system from the task organization configuration file at startup and is considered to be static during runtime. In the course of an exercise, the Task Organization Hierarchy receives information from the Vehicle Status module about the operational effectiveness (OE) of the individual vehicles in the CVCC armor battalion. It uses this information to generate OE status information for the various units in the battalion.

- Operational Effectiveness (OE) Reports Submodule - controls the formatting of the OE reports, including: drawing individual bar graphs and their labels, positioning multiple bar graphs within a single report, and displaying OE status using the circle chart convention.

- TOOE Display Submodule - accesses the OE status information in the Task Organization Hierarchy Submodule and uses the drawing primitives in the OE Reports Submodule to display the operational effectiveness of any unit in the CVCC armor battalion as required by the user. Any TOOE Reports being displayed by the user are updated periodically from the latest data in the TO hierarchy. The default period for TOOE refresh is 30 seconds. This may be adjusted by setting the *tooeSecsPerUpdate* resource in the "BnToc" *xresource* file.

Position Navigation (POSNAV) module.

The Position Navigation (POSNAV) Module controls the display of POSNAV icons, which indicate the current locations of vehicles and units on the tactical map. The POSNAV icons can be displayed to any level of aggregation, from individual vehicles to the entire armor battalion. The POSNAV Module continually updates the locations of the vehicles of the battalion, based on reports received from the CCDs in the individual tanks. The POSNAV Module uses this information to calculate and display the unit locations for all the platoons and companies in the battalion, as well as for the CVCC armor battalion itself. Unit locations are based on a "center-of-mass" algorithm. The center-of-mass algorithm computes the weighted average location of all vehicles in a unit; once the center-of-mass has been calculated, vehicles outside a prescribed radius are identified as outliers; the center-of-mass is then recalculated, omitting the location of outliers from the calculation. In this way, damaged or destroyed vehicles do not skew the center-of-mass calculations.

The radius that controls the definition of outliers can be set differently for each level of aggregation. Table 2 lists unit levels and the default distance setting in meters from the center-of-mass beyond which vehicles are considered outliers:

Table 2

Default Distance Setting in Meters From the Center-of-Mass Beyond Which Vehicles Are Considered Outliers, According to Unit Level

Unit Level	Default Distance
Section	750
Platoon	750
Company	1750
Battalion	5000

These default settings can be overridden at runtime using the parameters summarized in Table 5 of Appendix C.

The POSNAV Module architecture consists of the following two submodules (see Figure 15):

- POSNAV Hierarchy Submodule – maintains information on the current location of vehicles and units in a form similar to the TOOE hierarchy. However, whereas the TO hierarchy is static, the POSNAV hierarchy is dynamic and reflects only vehicles that are currently reporting their locations. Destroyed vehicles are not reflected in the POSNAV hierarchy. In the course of an exercise, the POSNAV Hierarchy Submodule receives information from the Vehicle Status Module about the locations of individual vehicles in the CVCC armor battalion. The POSNAV Hierarchy Submodule uses this information periodically to regenerate the locations of the units in the battalion based on a center-of-mass algorithm. Vehicles that do not report their location before the POSNAV timeout are also considered destroyed and are not considered in the POSNAV hierarchy.

- POSNAV Display – displays the POSNAV icons on the tactical map and updates them in response to the latest information about vehicle and unit location contained in the POSNAV Hierarchy Submodule. To control the amount of redrawing required, the POSNAV Display Submodule updates the POSNAV icons on the map from the latest information in the hierarchy every 10 seconds. The POSNAV Display Submodule also reacts to user commands to change the aggregation levels of the POSNAV icons displayed on the tactical map.

<u>Report module</u>.

The Report Module enables the user to edit, send, receive, store, organize, display, and post formatted Army reports, including Adjust Fire reports, Call-For-Fire reports, Contact reports, Free Text reports, Intel reports, NBC reports, Shell reports, SitRep reports, and Spot reports. The Navigation Module, a CCD-specific extension to the Report Module, is described after the Report Module.

- Edit – The Report Module enables the user to edit the formatted Army reports listed above (with the exception of Free Text Reports).

  In the CCD, the CITV Laser Range Finder can be used to fill in report locations. As mentioned in the section describing data collection protocol, the CCD does this by listening for CITV status packets belonging to the data collection protocol which are sent by the associate vehicle simulator.

- Send and receive – The Report Module enables the user to send and receive the formatted Army reports listed above (with the exception of Free Text reports) on the various platoon, company, and battalion command networks as defined by standard Army practice.

- Filter – Users of the BnTOC Workstations can filter out report types that do not interest them.

- Aggregate – When the Report Module receives a Spot report, Contact report, or Shell report, it checks the list of reports that have not yet been acted on for those that refer to the same battlefield event. Two reports are considered to refer to the same battlefield event if they occurred in "close proximity" in terms of time and distance. The default definition of "close proximity" is 5 minutes and 1 kilometer. Two reports that are deemed to refer to the same battlefield event are aggregated into a single report containing the weighted average of the two reports in terms of time, distance, and numbers of objects observed. The original reports are replaced by the new aggregate report; however, they are not deleted. Rather, they are attached to the aggregate report and can be read by the operator if so desired. In this way, sightings of the same battlefield event by independent observers will be aggregated into a single report, easing the operator's work load.

- Store – The Report Module stores newly created and newly received reports into the Report Database. Each report has a unique identifier and is tagged with pertinent information such as the creation time, the arrival time, the recipient to whom the report was forwarded, and whether or not the report is currently posted.

- Organize – The Report Module enables the user to organize the reports into groups, or "folders." In the BnTOC, reports are placed in a receive queue as they are received. BnTOC users can create and delete folders to customize their filing scheme, the so-called Workbook. Reports are not automatically grouped into folders once they have been viewed; action must be taken on reports to place them in workbook folders, or they age into a Miscellaneous Folder. However, viewed reports are automatically maintained in a special Journal folder, which provides the capabilities of the standard Army report journal. Users can view the contents of Workbooks and Journals located at any of the BnTOC Workstations on the BnTOC network.

CCD users have a less flexible organization scheme. Reports are placed in a receive queue as they are received from the communications networks. After they have been viewed, reports are automatically grouped into folders by report type.

- Display and post – The Report Module enables the user to display reports received. Icons corresponding to the critical battlefield locations contained in the report are displayed on the tactical map while the reports are being displayed. For example, the target locations and target types contained in Contact reports are displayed on the tactical map. Report icons can be posted to the tactical map permanently or until explicitly removed by the user. BnTOC users have the additional capability of posting reports to and unposting reports from the TOC Situation Display.

The Report Module consists of the following submodules (see Figure 16):

- Report Database Interface Submodule – provides the report storage capabilities described above.
- Report Manipulation Submodule – provides the capability to edit, send and receive, aggregate, filter, and post reports.
- Report Folders Submodule – provides the capability to organize reports into folders. In the BnTOC, this is used to implement the Workbook and Journal. In the CCD, it is used to implement the report-specific folders.
- Report Display Submodule – provides the capability to display folders and reports, and presents all the other capabilities to the user in a unified graphical user interface.

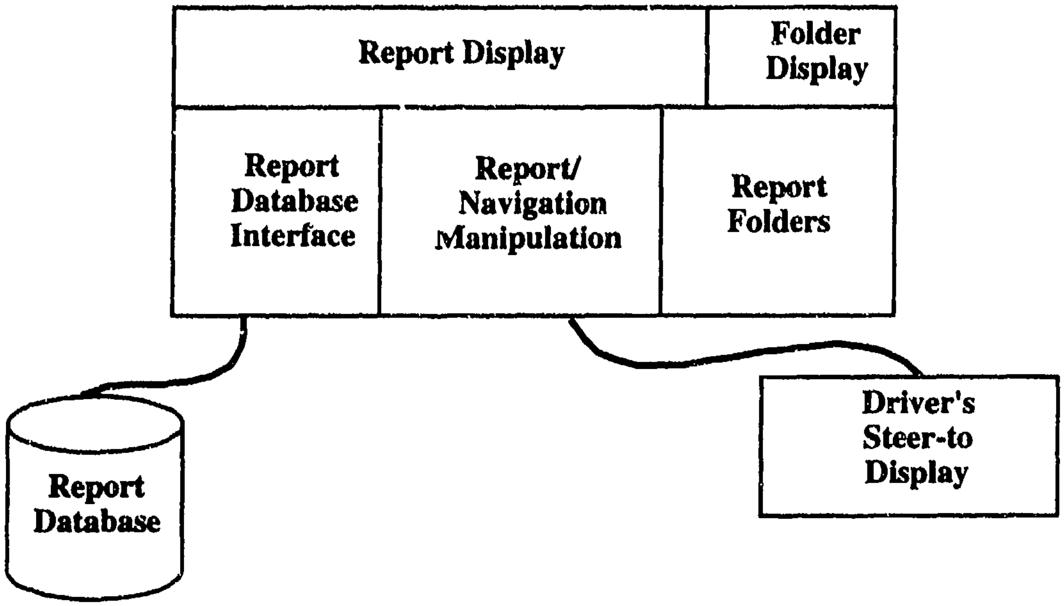

Figure 16. Report module and Navigation module.

Fire Support module.

The Fire Support Module provides support for editing and viewing Call-For-Fire reports. Target locations can be specified using either Target Reference Points (TRPs) from Fire Support Overlays or UTM coordinates when composing Call-For-Fire reports.

The Fire Support module does not have architectural submodules.

Exercise Control module.

The Exercise Control Module provides exercise control support for running an exercise. It implements the Checkpoint, Restart, and Shutdown operations for the BnTOC Workstation and CCD simulation. In addition, the Exercise Control Module provides the capability of initiating these operations, from a single point of control, by convention, one of the BnTOC workstations. The Checkpoint operation causes BnTOC Workstations and CCD simulations to save their current state under a user-specified identifier so that they can be recovered later. The Restart operation recovers the specified state previously saved in a Checkpoint operation. The Checkpoint/Restart combination allows an exercise to be suspended for any amount of time and then continued with no negative effect. The Shutdown operation causes the BnTOC Workstation and the CCD simulation to exit.

The Exercise Control Module does not have architectural submodules.

Configuration module.

The Configuration Module keeps track of the call sign and duty position information for every BnTOC Workstation and CCD simulator participating in an exercise (for example, BnTOC Workstation "A" has the call sign "Y06" and the duty position of "battalion 1 commander," or CCD simulator "B" has the call sign "A06" and the duty position of "battalion 1, company A commander"). At startup, this information is read from a centralized network configuration file into each BnTOC Workstation and CCD simulator participating in the exercise. It is updated over the course of an exercise in the unusual event that a BnTOC Workstation or CCD simulator playing a critical role (such as the battalion commander) fails and needs to be replaced. The BnTOC Workstations use this information to access overlays, folders, and formats on other BnTOC Workstations directly over the network.

The Configuration module does not have architectural submodules.

Communications module.

The Communications Module sends and receives data across the simulation network for the BnTOC Workstations and CCD simulators.

The Communications Module provides support for the following types of data communications:

- Point-to-point – for sending command and control data from BnTOC Workstation to BnTOC Workstation. This capability is currently used for routing reports only.

- Radio multicast – through the use of radio-based military networks for CCD-to-CCD, CCD-to-BnTOC, and BnTOC-to-CCD command and control data communications. Currently, the Communications Module provides support for platoon, company, and battalion radio voice and digital command nets for the CVCC armor battalion, with or without the SINCGARS radio simulation.

* Broadcast - for sending exercise control and configuration data to all BnTOC Workstations and CCD simulators participating in the exercise.

The Communications Module is implemented as a library which is used by both the BnTOC workstation and the CCD. The architecture of the Communications Module is divided into three submodules, as depicted in Figure 17.

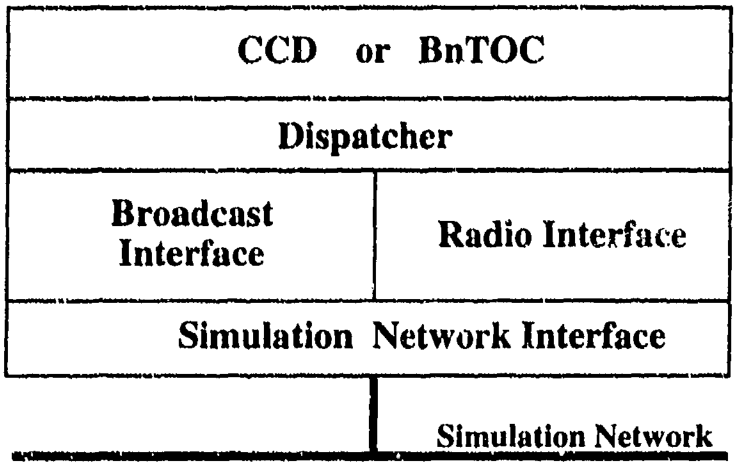

Figure 17. CCD Communications module.

The Simulation Network Interface submodule manages the connection to the simulation network by opening and closing the network connection, providing routines for writing data to the simulation network, and providing a subscription service for incoming packets. A subscriber of the Simulation Network interface may select a protocol and (optionally) a kind of packet within that protocol, then specify the processing to be performed for those selected packets. For example, the BnTOC would specify that a shutdown function would be run whenever a shutdown packet in the CVCC protocol is received.

The Radio Interface submodule manages the connection between the CVCC application (BnTOC or CCD) and associated SINCGARS radio simulator (when in use) by communicating with it via the CVCC protocol. In order to communicate with the SINCGARS simulator, the simulation network is accessed through the Simulation Network Interface.

The Radio Interface uses the services of the Simulation Network Interface not only to communicate with a SINCGARS radio simulator, but also to provide a higher-level interface for sending and receiving radio messages.

The Radio Interface submodule provides the ability to send messages point-to-point or broadcast on a selected set of radio networks. The supported radio networks simulate military (command) networks, such as the Battalion Command Net or Company A Command Net. The Radio Interface submodule provides this service whether or not a SINCGARS radio simulator is being used to simulate the transmission of the messages. When a SINCGARS radio simulator is not being used (due to its configuration or failure of the radio simulator), the Radio Interface submodule automatically simulates perfect radio transmission by sending the information directly to the recipients (via the Simulation Network Interface submodule).

The Radio Interface submodule provides a subscription service analogous to the service provided by the Simulation Network Interface submodule. The subscriber may specify what processing should be performed when a particular kind of message is received.

The Dispatch Mechanism submodule provides a generic utility for providing subscription services. This submodule is used by both the Simulation Network Interface submodule and the Radio Interface submodule to implement their subscription services.

BnTOC-specific Modules

Concept-of-Operations submodule.

The Concept of Operations (COO) Submodule is an extension to the Overlay module that is available only on the BnTOC Workstation. The COO Submodule enables the user to edit and display concept-of-operations overlays on the tactical map. Concept-of-operations overlays consist strictly of unit icons belonging to an organic task organization hierarchy such as an armor battalion. The task organization hierarchy can be de-aggregated to the desired level, and each of the resulting unit icons in the task organization can be placed in a series of battlefield locations corresponding to the unit's battle positions for the various phases of the operation. By stepping the unit icons through their battle positions, the user can reveal the operation phase by phase.

Format module.

The Format Module enables the user to edit, store, and display the following standard Army formats: AnalAreaOpns, EstSit, IntelEst, OpnSit, OpnsOrd, PerIntel, PerOpnRpt, RoadMvt. As a starting point when editing a format, the user is provided with a job aid template that outlines the paragraphs contained in the format. The user at each BnTOC Workstation can view and copy formats from any of the other BnTOC Workstations on the BnTOC network.

The Format module does not have architectural submodules.

CCD-specific Modules

Own Vehicle Status submodule of Vehicle Status module.

The Own Vehicle Status Submodule listens for two types of data packets from its associate vehicle simulator. Vehicle Appearance packets belonging to the Simulation Protocol contain information about the vehicle location, vehicle heading, turret orientation, and the vehicle status, including fuel and ammunition levels, and subsystems status. CITV Orientation packets belonging to the CVCC protocol contain information about the current CITV orientation. The Own Vehicle Status Submodule uses this vehicle location, vehicle heading, turret orientation, and CITV orientation information to update the "own tank" icon on the CCD tactical map. It passes the vehicle status information to the Aggregate Status Submodule to be sent to other vehicles.

Navigation module.

The Navigation Module is an extension to the Report Module and is available in the CCD simulation only. The Navigation Module enables the tank commander to edit, send, receive, display, post, and store routes in the form of a series of waypoints. In addition, the Navigation Module provides an interface for automatically sending to the tank driver the direction and distance to the next waypoint.

The Navigation Module uses the Report Database Interface, the Report Manipulation, and the Report Folders submodules to provide the capability to edit, send, receive, store, display, and post routes. An extension to the Report Manipulation Submodule provides the capability to display routes. The Navigation Manipulation Submodule supports the interface to the tank driver.

Duplicated Modules

Instrumentation module.

The Instrumentation Module provides the capability to send data about how the users of the BnTOC Workstation, CCD, and CITV are using the systems to support the data collection requirements of the CVCC experiments at the MWTB. Specifically, it supports sending PDUs belonging to the instrumentation subprotocol. (For more detailed information, see the section on the instrumentation subprotocol.)

User interface.

The user interface is not a separate module. Rather, it is distributed across a number of different modules, including the Map Module, the TOOE Module, the Report and Navigation Module, the Overlay and COO Module, and the Format Module. Each of these modules contributes to the user interface. However, because of the differences in the capabilities of the display software and hardware used by the BnTOC Workstations and the CCD simulators, most of the code used to implement the user interface is duplicated in the two systems.

BnTOC Workstation and CCD Simulation Data Flow

This section presents a unified view of the modules that make up the BnTOC Workstation and the CCD simulation. Since the central focus of the BnTOC Workstation and CCD simulation is the communication, manipulation, and display of data, a data flow diagram (Figure 18) is used to present this unified view. The discussion below follows the path of a piece of data (i.e., a PDU) from the point at which it enters the system to its final destination, where it is processed.

When new PDUs are read by the simulation network interface, they are checked to see what type of interface they are using. Broadcast packets contain control data and are routed to the Broadcast Interface of the Communications Module, whereas multicast packets contain command and control data and are routed to the Radio Interface.

Packets arriving at the Broadcast Interface are passed to the Dispatcher, which checks what type of control data the packet contains. Exercise control data (i.e., Checkpoint, Restart, and Shutdown commands) are passed to the Exercise Control Module, where the contents are read and a Checkpoint,

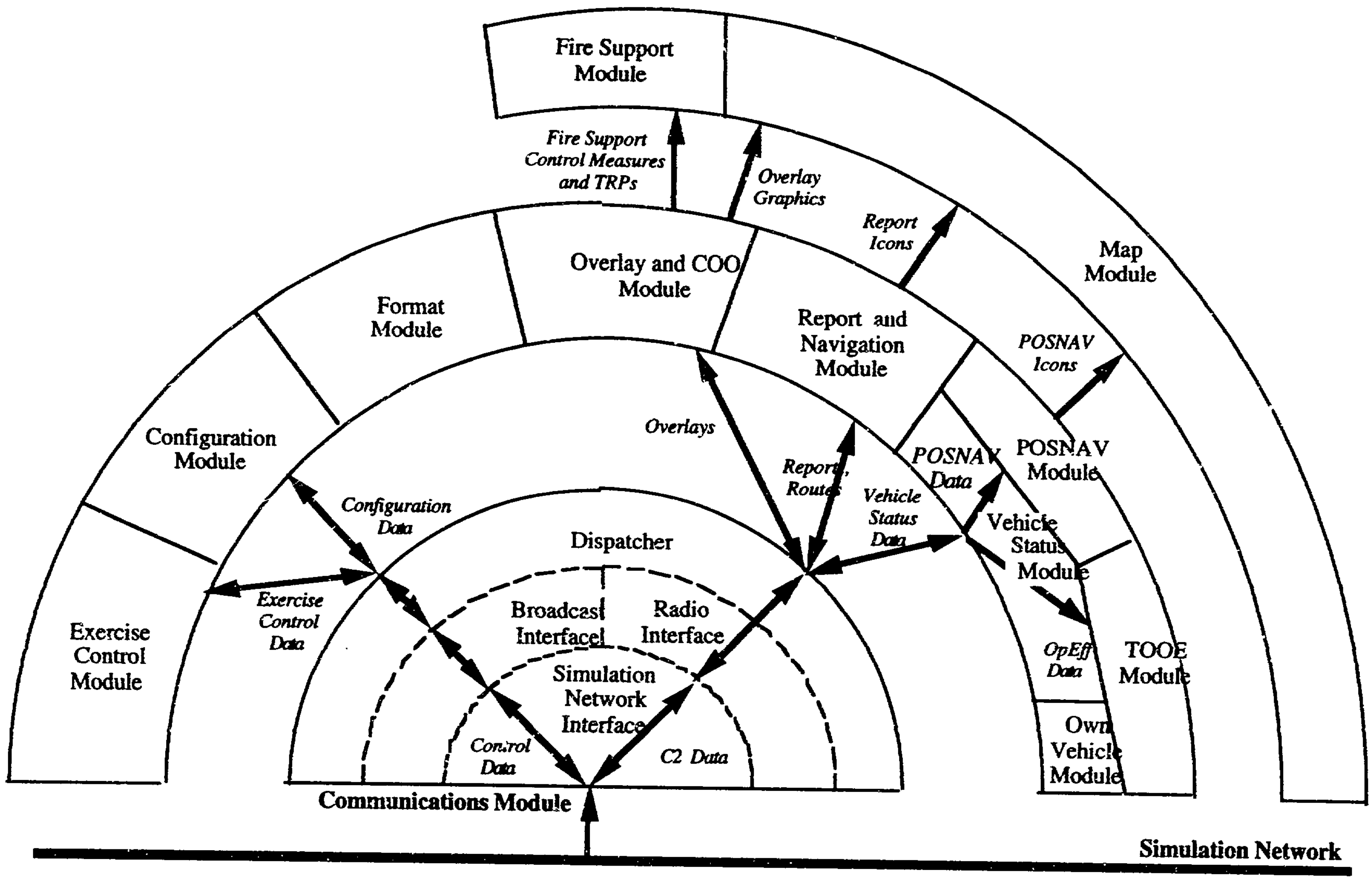

Figure 18. BnTOC and CCD data flow diagram.

Restart, or Shutdown operation is carried out. Configuration data are passed to the Configuration Module, which updates its tables that map simulation hosts to duty position roles and call signs in the exercise.

Packets arriving at the Radio Interface are examined to make sure that they are from a SINCGARS with which this simulator is associated (if SINCGARS simulators are being used) or to make sure that they are from a radio net to which this simulation is connected (if SINCGARS simulators are not being used). Packets that pass this test are sent to the Dispatcher, which checks what type of command and control data the packet contains. The Dispatcher forwards the data appropriately: overlay data to the Overlay and Concept-of-Operations Module; reports and routes to the Report and Navigation Module; vehicle location data to the POSNAV Module, and vehicle status data to the TOOE Module. Each module then processes the data as follows:

- The Overlay and Concept of Operations Module places the data in the overlay database and makes it available to the user for display. If the user chooses to display the overlay, the Overlay Module posts the objects in the overlay (point icons, unit icons, control measures, etc.) to the map.

- The Report and Navigation Module processes reports and routes in a similar manner. New reports are stored in the report database and an entry is made in the "receive" folder. Displaying the contents of a report causes the information in the report (such as target and observer locations) to be posted to the map in the form of report icons.

- The TOOE Module uses the vehicle status data passed to it to update its TOOE hierarchy. Any TOOE reports being displayed by the user are updated from the latest data in the hierarchy.

PROTOCOLS USED BY THE CVCC SIMULATIONS

The CVCC simulations use portions of the following protocols to support their communications and interactions:

- simulation protocol
- data collection protocol
- radio simulation protocol
- CVCC protocol

The Simulation protocol section describes how the simulation protocol is used to support interactions between the various CVCC simulations, concentrating on the individual systems which make up the CVCC-equipped tank simulation (LADS, 1991d).

The Radio simulation protocol section briefly describes the portion of the data collection protocol which is used to support interactions between the CITV portion of the enhanced M1 tank simulator and the CCD (LADS, 1991d).

The CVCC protocol section provides a brief synopsis of the description of the radio simulation protocol appearing in documentation about the SIMNET Simulation of Radio Communication (Pope et al., 1990).

The CVCC protocol was created specifically to support the needs of the CVCC system. It is described in full in this section.

Simulation Protocol

The CCD and SINCGARS simulators use the simulation protocol to obtain information about the vehicle with which they are associated. As mentioned previously, the enhanced M1 tank simulator, the CCD simulator, and the SINCGARS radio simulator are combined to produce the simulation of the CVCC-equipped tank. The enhanced M1 tank simulator works independently of the other two simulators and is unaware of whether they are connected to the simulation network. The CCD and SINCGARS simulators, on the other hand, are associated with a particular enhanced M1 simulator at runtime. They obtain information about that vehicle by listening to the Vehicle Appearance PDUs that it broadcasts to the simulation network.

The CCD simulator extracts location and state information from the Vehicle Appearance PDUs and uses it to draw its own vehicle icon with the correct turret orientation at the correct location on the tactical map display. The CCD also communicates status information extracted from the Vehicle Appearance PDUs to other CCD and BnTOC workstation simulators.

The SINCGARS simulator listens for Vehicle Appearance PDUs from all vehicles that have radios. It uses the location information in those PDUs to keep track of the locations of the vehicles (and thus the radios) and to help determine which radios can communicate with one another. The SINCGARS simulator also uses the state information in Vehicle Appearance PDUs from its own vehicle to help determine its own state. For example, if its vehicle is destroyed, the SINCGARS knows that it should cease transmitting or receiving.

The BnTOC workstations do not use the simulation protocol.

Data Collection Protocol

The data collection protocol is used to support the interoperability between the individual systems which together make up the CVCC tank simulation. Specifically, the enhanced M1 tank simulator uses the data collection protocol to communicate information about how the tank's Laser Range Finders (LRF) are being used. The CCD uses this information when filling out reports. In this way, the CCD supports entering report locations using the CITV LRF.

The particular PDU used to support this interoperability between the CCD and the enhanced M1 tank simulator is the Laser Range Finder PDU. Laser Range Finder PDUs contain the following information:

- the identity of the vehicle being simulated
- the identity of the LRF being used (gunner's LRF or CITV's LRF)
- the result of the LRF operation (malfunction, no locations returned, single location returned, multiple locations returned)

- a switch to identify which location to use if multiple locations were returned (no return, first return, last return)

- the location returned by the LRF operation

Radio Simulation Protocol

The SINCGARS radio simulations use the radio simulation protocol to report noteworthy events and statistics to each other, as well as to simulate transmitting and receiving voice and data communications (Pope et al., 1990). The radio simulation protocol includes:

- Transmitter PDUs

- Receiver PDUs

- Signal PDUs

- Intercom PDUs

- Alert Operator PDUs

A simulated radio can be a receiver, a transmitter, or, as in the case of the SINCGARS radio simulator, both. Transmitter PDUs and Receiver PDUs communicate state information about simulated transmitters and receivers, respectively. A radio simulation issues Transmitter PDUs and Receiver PDUs whenever either (a) the state of the transmitter or receiver changes, or (b) five seconds have elapsed since the last such PDU was issued.

The content of a radio transmitter's signal over a brief period of time is described by a Signal PDU issued by that transmitter's simulator. While a transmitter is broadcasting, its simulator repeatedly issues Signal PDUs to describe successive time segments of the transmitted signal. These PDUs are used by other radio simulators to decode a received signal.

A radio simulator may be privy to what is spoken over an intercom inside a vehicle as well as what is spoken for radio transmission. For example, the SINCGARS radio simulators obtain speech signals from each crew member's microphone, regardless of whether those crew members are transmitting on a radio. For study purposes, it may be desirable to record this intercom speech. The Intercom PDU is used to report intercom speech via the simulation network so that it can be recorded by a system such as the Data Logger. The Intercom

PDU contains the same information as the Signal PDU, except that the identity of the vehicle containing the speaker is substituted for the identity of the radio.

A radio simulator can emit a warning or alerting tone through a simulated radio receiver's speaker or headset. For example, the real SINCGARS radio is supposed to do this whenever data is transmitted. The Alert Operator PDU supports this functional capability.

CVCC Protocol

The CVCC protocol was created specifically to support the communications and interactions requirements of the CVCC System Architecture. The CVCC protocol breaks down into four different types of information and interactions.

- command and control data
- vehicle appearance data
- instrumentation data
- execution control operations

Each of these categories essentially constitutes a subprotocol of the CVCC protocol. The sections which follow described each of these subprotocols in turn.

Command and Control Subprotocol

The primary role of the CVCC protocol in the CVCC system architecture is to support the communication of command and control information between the various systems participating in an exercise. The command and control subprotocol supports this role.

The command and control subprotocol can be divided into two layers. The inner layer defines the content of the command and control information that can be communicated among the CVCC simulations (i.e., reports, overlays, vehicle location, and vehicle status). The outer layer defines the mechanism by which this information is communicated.

The command and control subprotocol is used by the BnTOC workstation, CCD, and SAF.

Inner Layer: Command and Control Information

Command and control information can be divided into two basic categories: saveable and transient. Saveable information includes reports, routes, and overlays. Transient information includes vehicle location and vehicle status information. Saveable information generally becomes part of a command and control database (which is either private, as in the case of the CCD simulators, or shared, as in the case of the BnTOC workstations). Transient information is generally used only for display purposes. It is usually updated automatically and discarded once it is out of date.

Reports – Nine different Army reports are supported by the command and control protocol:

- Adjust Fire Report
- Call-For-Fire Report
- Contact Report
- Shell Report
- SitRep Report
- Spot Report
- Intel Report
- Free Text Report
- NBC Report

BnTOC workstations and CCDs can send and receive all CVCC reports listed above except Free Text Reports—these can be prepared and sent, and received and forwarded by BnTOC workstations, but only received and forwarded by CCDs. In addition, to make SAF vehicles behave more like manned vehicles, they have been given the ability to send Contact, Shell, and Spot reports. In the CVCC MWTB environment, this means they have command and control capabilities similar to those of the real CVCC-equipped tank.

The Adjust Fire Report includes:

- Suppress versus Fire-for-Effect indicator
- End-of-Mission indicator

- identifier of the Call-For-Fire Report with which the Adjust Fire Report is associated

- either an absolute target location or a specification of the number of meters to add/subtract and shift left/right

The Call-For-Fire (CFF) Report includes:

- location of the observer

- target location and target type (the target can be a tank, anti-tank guided missile, helicopter, fixed-wing aircraft, artillery, personnel carrier, truck, or troops)

- number of targets sighted

- concentration number (if one exists) corresponding to the specified location

The Contact Report includes two target/location entries.

The Shell Report includes:

- location of the shelling

- number of shells involved

- time when the shelling occurred (as opposed to when the report was created)

The SitRep Report includes:

- endpoints of the front line of troops (FLOT)

- enemy's activity level (low, medium, or high)

- enemy's activity type (air attack, ground attack, firing, defending, delaying, or reconnaissance)

- commander's intention (no change, attacking, reconnaissance, defending, delaying, or withdrawing)

- indications about critical shortages of ammunition, equipment, fuel, and personnel

- time to which the situation report refers (as opposed to the time when it was created)

The Spot Report includes:

- location where the activity was observed
- what was seen (tank, anti-tank guided missile, helicopter, fixed-wing aircraft, artillery, personnel carrier, truck, or troops)
- number of units seen, damaged, and destroyed
- enemy's heading
- enemy's activity and own actions (air attack, ground attack, firing ,defending, delaying, reconnaissance)
- time when the observation occurred (as opposed to the time when the spot report was created)

The Intel Report includes information about enemy units, friendly units, and obstacles.

The information about enemy and friendly units includes:

- unit location
- for enemy forces: type of units involved (tank, anti-tank guided missile, helicopter, fixed-wing aircraft, artillery, personnel carrier, truck, troops)
- for friendly forces: type of units involved (artillery, command and control, mechanized infantry, mortar, scout, support, tank)
- number of vehicles involved
- activity (air attack, ground attack, firing, defending, delaying, reconnaissance)

The obstacle information includes the location type of the obstacle:

- abati
- blown bridge
- minefield
- tank ditch

The Intel report also includes the time to which the report refers (as opposed to the time at which it was created).

The Free Text Report includes 512 characters of text.

The NBC Report includes:

- the location of the observer
- the location of the attack
- the burst type (air, surface, unknown)
- the attack type (nuclear, biological, chemical)
- the flash-to-bang time
- the number of shells observed
- in the case of a nuclear attack, the size of the crater and the height and width of the nuclear cloud

Routes - are an ordered list of waypoints. Only CCD simulators send and receive routes.

Overlays - The CVCC protocol supports the communication of graphical overlays between applications, specifically overlays created using the symbols and standards defined in the Army Field Manual FM 101-5-1 (U.S. Army, 1985). Whether a given application can actually display these overlays depends on which library is used for drawing symbols.

The BnTOC workstation and CCD use the overlays portion of the command and control subprotocol to communicate graphical overlays, including OpOrds, FRAGOs, SitEsts, and Fire Support overlays. The CVCC command and control subprotocol is *not* capable of communicating Concept- of-Operations overlays.

In the CVCC protocol, graphical overlays are composed of three fundamental building blocks:

- point symbols
- poly-line objects
- text objects

Point symbols occupy a single point on the terrain. There are three basic categories of point symbols:

- vehicle icons (e.g., tanks, mechanized infantry vehicles, scout vehicles, etc.)

* unit icons (e.g., armor units, infantry units, etc.)

* point icons (e.g., waypoints, target reference points, etc.)

Point symbols include information identifying the type of point symbol (tank armor unit, waypoint, etc.) and the location of the object. Point symbols for unit icons have a unit size identifier (section, platoon, company, battalion, brigade, etc.). Any point symbol can have up to eight tags associated with it. Each tag consists of a character string and information about where it appears relative to the core symbol (above, below, three positions on the left, and three positions on the right). Finally, point symbols have attributes that identify their orientation (friendly or enemy) and their status (proposed or confirmed).

Poly-line objects occupy two or more points on the terrain. They can be used with text objects to create control measures. There are three categories of poly-line objects:

* lines (boundary lines, phase lines, etc.)

* arrows (direction of advance, axis of advance, etc.)

* polygons (restricted fire areas, minefields, etc.)

Poly-line objects include information identifying the following:

* type of poly-line object (boundary line, direction of advance, restricted fire area, etc.)

* location (specified by a list of vertices)

* how the object should appear when drawn, including:

  * unit size identifier (section, platoon, company, etc.)

  * location of the unit size indicator (i.e., the specific vertex)

  * whether the poly-line is splined (i.e., drawn with smoothing)

* orientation (friendly or enemy)

* status (proposed or confirmed)

Text objects can be used to represent comments on the overlay or to create text labels for poly-line objects. They include:

- type of text object (comments or poly-line labels)
- location of th text on the overlay in Universal Transverse Merc r (UTM) coordinates
- offset from the lc ior (in screen coordinates)
- character string o e text itself

Vehicle location and status – The CCD simulations receive location and status information about their vehicles from the simulation and data collection protocols, respectively. They share this information with other CCD simulations using the Vehicle Status packets of the CVCC command and control subprotocol. The CCD simulations also communicate the current Task Organization characteristics of the vehicle (and, by extension, the tank commander). To make the distinction between manned and unmanned (SAF) CVCC simulations invisible to the user in the CVCC experime s, the SAF vehicles have been given the capability of sendi ng this vehicle status information via Vehicle Status and Group Status packets.

The Vehicle Status packet includes information about the following:

- location of the vehicle. This information is used by the BnTOC workstations and CCD simulators to draw vehicle and unit icons on the tactical map.
- status information used by the BnTOC workstations and CCD simulators to present the Operational Effectiveness of the tank battalion and its component units:
  * ammunition status - including the types of ammunition and the number of rounds of each type available
  * equipment status - whether its fire and mobility subsystems are functioning
  * fuel status - number of gallons of fuel available
  * personnel status (okay, wounded, killed) of each of the crew members (commander, gunner, loader, driver). (Note: In the current simulation

personnel status is not tracked. Rather, it is always assumed to be okay.)

- current task organization of the vehicle, including:

  * duty position of the tank commander in the battalion

  * duty position of the person to whom the tank commander is *currently* reporting

  * whether the tank commander is currently leading a unit

  * unit currently led by the tank commander

  (The information about task organization is included in the Vehicle Status packets to support two functional capabilities: the display of the operational effectiveness of vehicles and units within the combat organization, and dynamic changes to the task organization of units within the overall combat organization. The latter capability is not currently available in either the BnTOC workstations or the CCD simulators.)

The Group Status packet simply provides a way of grouping Vehicle Status packets for more efficient communications over the simulation network.

Outer Layer: Data Communications

The outer layer of the CVCC command and control subprotocol allows the BnTOC workstation, CCD, and SAF simulations to share the command and control information described above. This layer consists of the following types of PDUs:

- Broadcast PDU

- Transmit Request PDU

- Transmit Response PDU

- Receive PDU

- Point-To Point PDU

The Broadcast PDU is used by the CVCC applications to share command and control information without using the data communications services of the SINCGARS simulation. The SAF simulators always use Broadcast PDUs to transmit command and control information. The Transmit Request PDU, Transmit

Response PDU, and Receive PDU are used by the CVCC applications to share command and control information using the data communications services of the SINCGARS radio simulation. The Point To Point PDU is used by BnTOC workstations to send command and control information directly to one another.

The command and control information in the Broadcast PDUs transmitted by the SAF simulators to the other CVCC applications on the simulation network includes spot reports, contact reports, CFF reports, and vehicle status packets (see the section on the inner layer: command and control information). SAF simulators only send command and control data to the simulation network. They never receive it.

The BnTOC workstations and CVCC simulators can operate either utilizing SINCGARS radios for data communications or by placing the data packets directly on the simulation network. (See the section on data communications without SINCGARS.)

The BnTOC workstations do not use the SINCGARS radio simulators to send command and control to each other, since they are co-located within the same TOC. When BnTOC workstations send command and control information directly to one another, they use the Point To Point PDU.

The next three sections summarize the PDUs that belong to the data communications layer of the CVCC command and control subprotocol.

Data communications without SINCGARS.

Broadcast PDUs are used by the CVCC applications to communicate command and control data directly without using the SINCGARS radio simulation. Broadcast PDUs also include the identity of the sender and the command network being used to carry the message (battalion command net, Company A command net, Platoon A/1 command net, etc.). This mode is useful when running the CVCC simulator on a standalone network that does not have SINCGARS simulators.

Data communications with SINCGARS.

Transmit Request PDUs, Transmit Response PDUs, and Receive PDUs define the interface made available by the SINCGARS radio simulation to applications that use its RIU data communications capabilities. The simulation of the RIUs in the SINCGARS radios provides data communications in various modes, including reliable and unreliable point-to-point, reliable and unreliable multicast, and unreliable broadcast transmissions. Although all of these modes are supported in the interface as defined by the Transmit Request, Transmit Response, and Receive PDUs, only the unreliable broadcast mode is used by CCD and BnTOC.

The Transmit Request PDU is used by an application to request communication of a message by an RIU. It includes the following information:

- identity of the radio transmitter
- command network carrying the message (battalion command net, Company A command net, Platoon A/1 command net, etc.)
- the message itself
- Information used to tell the RIU what mode to use for the transmission:
    * serial number identifying the request
    * an indication of whether the transmission is intended for all receivers (broadcast) or a subset (point-to-point or multicast)
    * an indication of whether the transmission is to be reliable (needs to be acknowledged) or unreliable (does not need to be acknowledged)
    * priority of the communication
    * list of recipients

The Transmit Response PDU is used by the RIU in the radio simulator to report back to the requesting application the results of trying to communicate a message. It includes:

- identity of the radio transmitter
- command network carrying the message (battalion command net, Company A command net, Platoon A/1 command net, etc.)
- serial number of the original transmit request PDU
- list of the failing receivers

The Receive PDU is used by the RIU in the radio simulator to convey a received message to an application (i.e., CCD). It includes:

- identity of the radio transmitter
- command network carrying the message (battalion command net, Company A command net, Platoon A/1 command net, etc.)
- the message itself

Data communications between the BnTOC workstations.

The BnTOC workstations communicate command and control information between themselves using the Point To Point PDU. The Point To Point PDU allows BnTOCs to send information to any subset of the supported BnTOC workstations. This separate mechanism is supported by BnTOC workstations because co-located TOC workstations in the field would be unlikely to be networked together via radios. Instead, workstations would be likely to be connected directly to each other using an local network, enabling them to communicate directly with each other.

The Point To Point PDU contains a list of BnTOC workstation recipients (e.g, BnCO, BnS2) and the message being sent. The message contains an identification of the sender, an indication of the type of information being sent and the data itself.

Vehicle Appearance Subprotocol

The vehicle appearance subprotocol of the CVCC protocol supports the special requirements of the enhanced M1 tanks to describe the orientation of the CITV. This information is used by the CCD to properly depict the icon for its own vehicle on the tactical map.

The vehicle appearance subprotocol consists of a single PDU, the CITV Orientation PDU, which contains the following information:

- the identity of the vehicle being simulated
- the angle describing the azimuth of the CITV
- the angle describing the elevation of the CITV

Instrumentation Subprotocol

The CVCC instrumentation subprotocol was designed specifically to support the data collection needs of the CVCC experiments at the MWTB. It allows the BnTOC workstations, CCD simulations, and the CITV simulation to communicate information to the simulation network about how they are being used by the soldiers participating in the experiments. This information can be saved by a program such as the data logger and analyzed using data analysis software. Thus, the CVCC instrumentation subprotocol provides the means to measure the effectiveness of the prototype weapons and the command and control systems that are the focus of the experiment. The information in the instrumentation subprotocol is critical to the entire ARI effort.

The CVCC Instrumentation subprotocol includes the following PDUs:

- CITV Instrumentation PDU
- CCD Instrumentation PDU
- BnTOC Instrumentation PDU

Each of these PDUs communicates information to the simulation network about how the corresponding simulation is being used.

The CITV Instrumentation PDUs are sent to the simulation network periodically and contain the following information:

- identity of the vehicle to which the CITV belongs
- mode of the CITV (off, cooling, search mode, auto scan mode, gunner's line-of-sight mode, GPS mode, standby)
- CITV magnification (3x, 10x)
- CITV polarity (white hot, black hot)
- state information, including whether the designator is pushed, whether the commander's stack button is pushed, and whether the gunner's stack button is pushed (when the target stacking is enabled).
- left and right sector limits and the scan rate, if the CITV is in auto scan mode

The CCD Instrumentation PDUs report information about the generation of Army reports, actions taken on messages, the current state of the tactical map, and cumulative action and object counts:

- generation of Army reports. These PDUs are sent by the CCD simulators when the reports are generated and include the following information:

  * unique identifier for the report

  * amount of time that the user was actively engaged in creating the report

  * action taken on the report (cancel, send)

  * type of report (Adjust Fire, CFF, Contact, Shell, SitRep, Spot, Intelligence, Free Text, NBC)

- actions taken on messages. These PDUs are sent by the CCD simulators when the action occurs and include the following information:

  * unique identifier for the message

  * call sign of the originator

  * call sign of the sender

  * message type (report, route, overlay)

  * type of report (if the message is an Army report): Adjust Fire, CFF, Contact, Shell, SitRep, Spot, Intelligence, Free Text, NBC

  * action performed on the message: relayed, relayed up, relayed down, saved, deleted, viewed, received, removed from receive queue by user, aged from receive queue by system, posted to the tactical map, unposted from the tactical map, route was made the active route

  * method by which the user selected the message for viewing (if the action performed was to view the message): from the receive queue, from an "old message" file, or by touching a report icon on the tactical map

- current state of the tactical map. These PDUs are sent periodically by the CCD simulators and include the following information:

  * map scale (1:25K, 1:50K, 1:125K, 1:250K)

* map features currently displayed (grid lines, rivers, roads, vegetation, buildings, contour lines)

* coordinates of the center of the map

* map scroll mode (jump mode, follow mode, move mode)

- cumulative action and object counts. These PDUs are sent periodically and include the following information:

  * type of the object or action being counted (high-priority messages in the receive queue, low-priority messages in the receive queue, thumb designator selects, touchscreen selects, locations specified by touching the tactical map, locations specified by using the Laser Range Finder)

  * map features currently displayed (grid lines, rivers, roads, vegetation, buildings, contour lines)

  * coordinates of the center of the map

  * map scroll mode (jump mode, follow mode, move mode)

The <u>BnTOC Instrumentation PDUs</u> report information about report events, folder events, overlay events, the current state of the overlay stack, and the current state of the tactical map:

- report events. These PDUs are sent by the BnTOC Workstations when the event occurs and include the following information:

  * unique identifier for the report

  * call sign of the originator

  * action taken on the report (report arrives, report is viewed, report is copied, report is linked to an overlay, report is relayed, report is aggregated, report is filtered, report is deleted)

    - For the <u>report arrives</u> event, this information includes the call sign of the sender.

    - For the <u>report is viewed</u> event, this information includes an identifier of the folder from which it is being viewed. This identifier includes the role of the BnTOC Workstation to which the folder belongs (BnCO/XO, BnS3, BnS2, BnFSO) and the name of the folder.

- For the report is copied event, this information includes the identifier of the source and destination folders of the report.

- For the report is linked event, this information includes the identifier of the overlay to which it is being linked. This identifier includes the role of the BnTOC Workstation to which the overlay belongs (BnCO/XO, BnS3, BnS2, BnFSO) and the name of the overlay.

- For the report is relayed event, this information includes the identifier of the folder containing the report and a list of recipients for the report (BnCommandNet, BnS1, BnS2, BnS3, BnS4, BnFSO, BnXO, BnCO, BnSitDisplay, BdeCommandNet).

- For the report is aggregated event, this information includes a list of the reports that form part of the aggregate report.

- For the report is filtered event, there is no additional information.

- For the report is deleted event, this information includes the identifier of the folder from which the message is being deleted.

* information about the event (depends on the type of the event)

- folder events. These PDUs are sent by the BnTOC Workstations when the event occurs and include the following information:

  * type of folder event (folder is created, folder is deleted, folder is viewed, folder is closed)

  * identifier of the folder on which the event is taking place. This identifier includes the role of the BnTOC Workstation role to which the folder belongs (BnCO/XO, BnS3, BnS2, BnFSO) and the name of the folder.

- overlay events. These PDUs are sent by the BnTOC Workstations when the event occurs and include the following information:

  * type of event (post, unpost, move to top, move to bottom, circle up, circle down, create, edit, send, delete, save, save as rename, copy)

  * identifier of the overlay on which the event is taking place. This identifier includes the role of the BnTOC Workstation to which the overlay belongs (BnCO/XO, BnS3, BnS2, BnFSO) and the name of the overlay.

  * for a <u>create</u> event, an indication of what type of overlay was created (normal, concept of operations)

  * for a <u>save as</u>, <u>rename</u>, or <u>copy</u> event, an the identifier of the source and destination overlays

- current state of the overlay stack. These PDUs are sent periodically by the BnTOC Workstations and include the following information:

  * a list of identifiers of the overlays currently posted to the map. Each identifier includes the role of the BnTOC Workstation to which the overlay belongs (BnCO/XO, BnS3, BnS2, BnFSO) and the name of the overlay.

- current state of the tactical map. These PDUs are sent periodically by the BnTOC Workstations and include the following information:

  * map scale (1:25K, 1:50K, 1:125K, 1:250K)

  * map features currently displayed (grid lines, rivers, roads, vegetation, buildings, contour lines)

  * coordinates of the center of the map

  * map scroll mode (scroll bars, auto scroll, drag scroll, home, go to, resize)

Execution Control Subprotocol

The CVCC execution control subprotocol, like the CVCC instrumentation subprotocol, has an administrative function in the CVCC experiments at the MWTB. It includes the Execution control PDU, which provides support for two types of exercise control capabilities:

- checkpoint operations
- shutdown of all CVCC applications

Checkpoint support - Checkpointing is the process by which a CVCC application saves its current state or context. This includes all information critical to the current operating context of the application. Receiving a command to create a checkpoint causes an application to save its current state. Receiving a command to recover a checkpoint causes an application to replace its current execution state with the saved execution state specified in the command. Receiving a command to delete a checkpoint causes an application to delete the specified checkpoint, which presumably had been previously saved.

The checkpoint support provided by the CVCC execution control subprotocol provides for three checkpointing operations: creating a checkpoint, deleting a checkpoint, and recovering a checkpoint. Each operation includes a text string identifying the checkpoint. The CCD and the BnTOC workstations currently participate in the checkpoint facility supported by the CVCC execution control subprotocol. The SAF has to be checkpointed manually and does not participate in the current checkpoint facility.

Shutdown support - The CVCC execution control subprotocol provides support for a shutdown command. Upon receipt of the shutdown command from the control application, all participating applications terminate.

CONCLUSION

The CVCC system represents a major accomplishment in terms of demonstrating the feasibility and utility of integrating a computer-based command and control system into the battlefield. The system has garnered much at ntion for its functionality and its ease of use. In additi , the architecture of the CVCC software provides a flexible system which allowed the functional capabilities of the simulators and the BnTOC to be varied utilizing software switches.

The system as it stands represents the concerted efforts of the customer, military experts, and the contractor to build the best possible system through an iterative process of specification, design, implementation, and testing. The lessons learned in each cycle served to focus the effort to refine and extend the system in the next phase. The result has been a base of software which is at once highly useful, usable, and configurable, and at the same time highly modular. Thus, it provides an excellent base to be built upon for future experiment.

A few words of warning to those who would do so. First, the CVCC system is by no means a finished product. It represents the best good-faith efforts of the customer and contractor to balance the need to provide the highest level of functional capabilities with the sometimes conflicting need for robust, error-free software. As one might expect, time and money ran out long before the ideas. A number of program errors were discovered in the software which were not corrected. (The list of open program errors is included at the end of this report as Appendix E.) As a result, a number of capabilities were specified and designed but never implemented.

Among these functional capabilities are extensions to the Fire Support Module capabilities, the addition of the ability to edit task organization hierarchies to the Task Organization Module, the addition of execution matrix editing and terrain reasoning to the Planning Workstation, and the addition of a Personnel Module. Other ideas have included extending the CVCC command and control protocol to support more of the command and control requirements of the Armed Forces into a single system, integrating artillery elements, close air support elements, and combat service support elements. Additionally, proposals have been made for integrating the BnTOC workstations and the SAF system to provide a system for training BnTOC officers or for seamlessly commanding units in an environment of manned and unmanned vehicles.

In summary, the CVCC system provides an excellent platform to build upon to test out command and control concepts for future systems. Potential users should be aware that some problems still exist in the software which may have to be corrected if this is to be accomplished. In addition, one of the great accomplishments of the CVCC experiment is the ease of use of the Man-Machine interface. This was accomplished as a result of considerable time and effort. Potential users of this software should not underestimate the amount of effort required when making plans to enhance the functional capabilities of the system.

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APPENDIX A

ACRONYMS AND TERMS

APPENDIX A ACRONYMS AND TERMS

A/D	Analog to Digital
ADDA board	Analog to Digital/Digital to Analog Converter
ADST	Advanced Distributed Simulation Technology
ALOC	The administration and logistics console of the MCC, providing a GUI for repair and recovery, resupply (fuel and ammunition).
APCHQ	Adaptive Pulse Code with Hybrid Quantization compression algorithm
APIU	Adaptable Programmable Interface Unit
ARI	Army Research Institute
BLUFOR	Friendly force vehicles
BnTOC	Battalion Tactical Operations Center
C3	Command, Control, and Communications
CAS	The close air support console of the MCC.
CCD	Command and Control Display. A prototype of a vehicle-based Command and Control system which allows the tank commander to send, receive, and manipulate various types of command and control data.
CECOM	Communications Electronics Command
CES	The combat engineering support console of the MCC.
CFF	Call-For-Fire
CIG	Computer Image Generator
CITV	Commander's Independent Thermal Viewer
CO	Commanding Officer

COO	Concept-of-operations overlay; consist strictly of unit icons belonging to an organic task organization hierarchy such as an armor battalion.
CPU	Central Processing Unit.
CRT	Cathode ray tube monitor
CSS	Combat Service Support
CVCC	Combat Vehicle Command and Control
CVSD	Continuously Variable Slope Delta compression algorithm
D/A	Digital to Analog
DARPA	Defense Advanced Research Projects Agency
DED	Dynamic Element Database
DI	Dismounted Infantry
DMA	Defense Mapping Agency
ECCM	Electronic Counter-Counter Measure
FLOT	Front line of troops
FSE	The fire support element console of the MCC
FSO	Fire Support Officer Workstation used by the fire support officer assigned to the battalion TOC from the divisional artillery battalion.
FWA	Fixed Wing Aircraft
GUI	Graphical User Interface
I/O	Input/Output
IFF	Identification Friend or Foe System
LADS	Loral Advanced Distributed Simulation
LAN	Local area network

MANPRINT Manpower and Personnel Integration

MCC Management, Command and Control. A set of consoles that allow exercise control and provide logistics and combat support. The MCC stations include a master console for exercise control called the simulation control console (SCC) and five other consoles that provide GUIs for repair and recovery, resupply (fuel and ammunition) called the administration and logistics console (ALOC), combat engineering support (CES), fire support element (FSE), and close air support (CAS) roles during an exercise. Each of these consoles communicates with the MCC backend (SAF Station) which, like the SAF Sim, is responsible for controlling the unmanned vehicles.

MCS Maneuver Control System

MWTB Mounted Warfare Test Bed

OE Operational effectiveness

OSF Open Software Foundation

Out-the-window
The view from a manned simulator

PDU Protocol Data Units

POSNAV Position Navigation

RIU Radio Interface Unit. Interface which negotiates between voice and data transmissions.

RWA Rotary Wing Aircraft

S2 Intelligence Officer

S3 Operations Officer

SAF Semi-Automated Forces. Many unmanned vehicles in the virtual environment under the control of a single operator. Using SAF makes it possible to run larger exercises without having to man every vehicle.

SAF Sim — The back end of the Semi-Automated Forces System, it runs the software model of the vehicle and associated weapons systems, simulating the vehicles requested by the user, and controlling their actions in response to the high-level commands from the front end.

SAF Station — The front end of the Semi-Automated Forces System, it provides a Graphical User Interface GUI from which the user can create and control groups of vehicles organized according to the doctrine of the armed forces of a number of different countries.

SCC — Simulation control console. The a master console of the MCC, used for exercise control.

SIMNET — SIMulation Networking; the linking of simulators for distributed simulation exercises used for tactical team training in armored warfare.

SIMVAD — SIMulated Voice Analog/Digital board; a speech I/O board used for converting voice from Analog to Digital, and from Digital to Analog.

SINCGARS — SINgle Channel Ground/Air Radio System. A new family of VHF-FM combat network radios designed to provide the primary means of command and control for combat units, combat support units, and combat service support units in the Army.

A table-top model is used in the battalion TOC for TOC-to-tank communications. A vehicle-based model is part of the overall CVCC tank simulation and is used for tank-to-tank and tank-to-TOC communications.

SitDisp — The electronic situation display

Steer-to display — Display mounted next to the T-bar steering wheel in the driver's compartment.

STRICOM — Simulation, Training and Instrumentation Command

TACOM — U.S. Army Tank and Automotive Command

TCU — Transportable Computer Unit

Tethering	Process of tying a manned or unmanned simulator to another maned or unmanned simulator
TO	Task Organization
TOC	Tactical Operations Center
TOOE	Task Organization and Operational Effectiveness
TPRs	Target Reference Points
UTM	Universal Transverse Mercator
XO	Executive Officer

APPENDIX B

THE S1000 TERRAIN DATABASE GENERATION PROCESS

APPENDIX B: THE S1000 TERRAIN DATABASE GENERATION PROCESS

Initially, S1000 database modeling tasks must be done sequentially. In the design task, data are collected from the real world location and the database is carefully defined in accordance with customer needs and CIG processing capability. Population parameters, such as object density and priority, are established using this information. These two steps, site data collection and database definition, must occur before construction begins. Land creation is the first construction step, followed by road and river development. After this step, the other processes may be carried out along parallel paths.

Three dimensional objects such as buildings and vehicles are created from drawings, photos, and scaled models. They can be placed on the terrain as static objects, or stored in a Dynamic Element Database (DED). These objects are enhanced by the application of textures.

Textures are created at the same time models are being developed. Color images are entered into the computer from a variety of sources, such as photographs. They are processed and loaded on the simulator hardware. A texture set contains approximately 150 unique entities, each producing additional apparent scene complexity, thereby providing more realism.

A three dimensional effect is produced by each two-dimensional "rotating-stamp" model for objects such as trees. The development process involves formation of a single polygon, and the application of a texture. This is especially useful in the development of foliage and explosions.

While models are created and textures are developed, objects can be placed on the pre-existing land as an ongoing population process. This is the most time consuming, subjective part of the database modeling process. Population requires constant consideration of a variety of variables. Judgements are made as to what is most important to include in each location for maximum training value within the CIG constraints.

At the completion of the population process, topological maps are plotted for use in navigation and combat training. Each map is an accurate depiction of the data contained in that location of the terrain database. Maps can be mass-produced by a print shop, or printed at Loral in small numbers.

Each phase mentioned above is iterative, involving numerous development-testing cycles, and customer reviews. Since each database construction project involves trade-offs between the creation of a realistic scene and the processing capability of the simulator, it is essential for all participants to have a complete understanding of the goals, options, and constraints of the CIG system.

There are limits to the processing capability of the CIG, which is directly affected by the desired number of active dynamic objects, frame update rate of the display, field-of-view, and viewing range. This processing capability must be considered to include only objects that will provide the most training value, based on customer participation in the development process.

APPENDIX C

RUNTIME PARAMETERS

Terrain Plane Colors

The colors used by the Color System Submodule may be configured by the user in the "Bntoc" or "CCD" *xresource* file. The available list of named colors to which the features may be set is located in the file */usr/openwin/lib/rgb.txt* (use the capitalized names). The following specifies sample settings for all the Color Submodule resources that may be set:

Table 3

Terrain plane colors

Parameter Name	Explanation	Default Value
*dirtColor:	used to set terrain background color	Wheat
*buildingColor:	used to set building color	Black
*fordColor:	used to set fordable water color	SkyBlue
*riverColor:	used to set non-fordable water color	Blue
*roadColor:	used to set road color	Red
*treeColor:	used to set vegetation color	ForestGreen
*loContourColor:	used to set low contour line color	Black
*hiContourColor:	used to set high contour line color	Black
*gridColor:	used to set grid line color	Black

Application Plane Colors

Table 4

Application plane colors

Parameter Name	Explanation	Default Value
*friendlyColor:	friendly icons and control measures	Blue
*enemyColor:	enemy icons and control measures	Red
*neutralColor:	neutral icons and control measures	Black
*obstacleColor:	obstacles	ForestGreen
*tagColor:	tags on friendly, enemy, and neutral icons and control measures	Black
*selectionColor:	used to indicate a selected object on an overlays	Black
*rubberColor:	used to draw rubber-banding box to select object on an overlay	Black
*hiliteColor:	used to highlight icons corresponding to messages being read	White
*navColor:	used to draw POSNAV routes	Black
*blinkFriendlyColor:	used in CCD to draw icons for newly arrived messages	Blue
*blinkEnemyColor:	used in CCD to draw icons for newly arrived messages	Red
*blinkNeutralColor:	used in CCD to draw icons for newly arrived messages	Black
*blinkObstacleColor:	used in CCD to draw icons for newly arrived messages	ForestGreen

Outlier Parameterization

The following table lists unit levels and the default distance setting in meters from the center-of-mass beyond which vehicles are considered outliers:

Table 5

Unit levels and default distance settings used to determine outliers

Unit Level	Default Distance
Section	750
Platoon	750
Company	1750
Battalion	5000

APPENDIX D

THE CVCC SOFTWARE SWITCH AND COMMANDS CATALOG

THE COMBAT VEHICLE COMMAND and CONTROL (CVCC)

Software Switch and Commands Catalog

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Software Switch and Commands Catalog

Background

The Fort Knox Field Unit of the U.S. Army Research Institute for Behavioral and Social Sciences (ARI) investigates training requirements for the Future Integrated Battlefield, using soldier-in-the-loop simulation. The Combat Vehicle Command and Control (CVCC) Project research program investigates advanced digital and thermal technologies to enhance mounted forces' command, control, and communications (C3) capabilities.

As part of ARI-Knox's research efforts concerning training requirements for future tank technologies an automated link from tanks to the battalion tactical operations center (TOC) was included as part of the CVCC project. The effort also derived some information concerning the delta in operational effectiveness which future technologies may provide. Two series of battalion level simulations were conducted. These efforts included: the development of information on problematic training areas, preliminary training requirements, soldier-machine interface issues and assessments of workload.

The systems simulated combined in the CVCC research are a Position Navigation System (POSNAV), and a Command and Control Display (CCD) (the POSNAV is embedded in the CCD). Further POSNAV information is displayed on a tank driver's Steer-to-Display. Additionally, the simulation includes a Commander's Independent Thermal Viewer (CITV), and the Single Channel Ground and Air Radio System Radios. A simulation of an automated battalion level TOC provided the capability for digital communications between commanders (battalion and company) mounted in tank simulators and the battalion staff. This TOC was equipped with computerized workstations for Planning (Executive Officer), Intelligence (S-2 Officer), Operations (S-3 Officer), and Fire Support (Fire Support Coordinator).

Computer software was developed to support the simulation of the functions required for the formative evaluation of such a system. In general, the software is in modular form and provides the capability to configure both the tank simulators and the TOC computerized workstations to fit the functionality required. Incorporated into the simulation software are software switches which allow various capabilities of the software to be exercised.

Purpose

The purpose of this catalog is to provide a concise compilation of the software switches and commands which can be used to configure the CVCC simulation software. In addition, there are two procedural descriptions provided.

(1) CVCC Command Line Options describes the CVCC command line options which are supported for the TOC and CCD processes.

(2) Connecting Simulated SINCGARS Radios to TOC Workstations describes the procedure to connect SINCGARS simulators to a specific TOC workstation so that the digital radio transmissions originate at the proper location on the terrain data base.

CVCC BnTOC and CCD Command Line Options

This section describes the CVCC command line options which are supported for the BnTOC and CCD processes.

The CVCC BnTOC and CCD processes are capable of providing a summary of supported command-line switches. To see the list of available options, invoke the process (BnTOC or CCD) with the -help command-line switch.

The process will print the list of available options and terminate.

Similarly, if the user supplies an unsupported command line option to a CVCC process, it will print the list of supported options and terminate.

The options consist of three classes: generic options, which are supported by both the BnTOC and CCD, BnTOC-specific options, and ccd-specific options. When the supported options are listed, the generic options are described first, followed by the options which are specifically supported by the type of process (BnTOC or CCD) which was invoked by the user.

The command line summary which is printed (with options listed alphabetically) is as follows:

Usage: <process_name> [-options ...]

GENERIC CVCC OPTIONS

Software Switch	Option
-active <dirName>:	Specifies the name of the active directory of the CVCC data directory.
-callSign <callSign>:	Specifies the call sign of the simulator. Overrides the network configuration file. This option is used to change the callsign which is automatically filled in for digital messages. The callsign can be edited manually for each message. However, if the exercise calls for an officer to be located in a tank where he would not by default be located, using this option will facilitate the generation of reports.
-chptFile <fileName>:	Startup using runtime state in specified checkpoint file.
-chptHome <dirName>:	Specifies directory to find checkpoint files.
-comNone:	C2 data comms disabled.
-comEthernet:	C2 data comms broadcast on ethernet.

-comRadio: C2 data comms using SINCGARS radios.
-comNoNet: C2 data not sent.
-configFile <fileName>: Specifies network configuration file.
-cpradius <dist>: Set radius for selecting conc pts to dist. This option is used to calibrate the maximum distance used for selecting a concentration point when the user fills out a Call For Fire message. If the distance from the cursor to the nearest concentration point on the screen exceeds the specified distance, the location of the cursor is used in filling out the location field. Other wise, the location of the nearest concentration point is used.
-debug <flags>: Specifies debug flags.
-dutyPosition <dp>: Specifies the duty position of the simulator. Overrides the network configuration file.
-exercise <exerciseID>: Exercise ID this system is participating in.
-fresh: Startup using a fresh runtime state.
-loopback: Loop C2 messages back to the message queue.
-memory: Use memory allocator to find memory leaks.
-netDevice <devName>: Specifies the simulation network device.
-nice <num>: See -processPriority.
-processPriority <num>: Specifies process priority. Valid range of <num> is 1 - 10, 10 highest.
-recover: Startup using the active runtime state.
-rootDir <dirName>: Specifies root directory of CVCC data directory.
-same: Run with all dialogues on the same screen.
-swap: Swap the screens used to display dialogues.
-tooeFile <fileName>: Specifies task organization configuration file.
-version: Print the current version number and exit.

These options all affect the initial state of the process. The -fresh option is used to insure that all prior messages, saved and posted overlays, map state (zoom level, scrolled location), and other context are cleared.

The -chptFile option allows the user to specify the name of a CVCC checkpoint to use for reestablishing the process context upon startup.

The -chptHome option may be used in conjunction with the -chptFile option to specify a non-default location for the checkpoint file (this may be necessary due to disk storage constraints).

The -recover option is used to recover the context of the previously run CVCC process. This option is used primarily to recover from an accidental termination of a CVCC process during an exercise.

-exercise <exerciseID>: Exercise ID this system is participating in.
This option is used to set the exercise ID of the exercise which the CVCC process will participate in. Setting the exercise ID on the command line will override any settings which may exist in resource files.

-comNone:	C2 data comms disabled.
-comEthernet:	C2 data comms broadcast on ethernet.
-comRadio:	C2 data comms using SINCGARS radios.
-comNoNet:	C2 data not sent.

-communication <mode>: Specifies communication mode. Valid values include NoNet, Ethernet, RIU.

These options all support the selection of a communications mode.
Normal modes for an exercise are -comRadio and -comEthernet. A CVCC process operating in comRadio mode will attempt to send digital messages using a SINCGARS radio simulator (which is configured in resource files). CVCC processes operating in comRadio mode are still capable of receiving messages from CVCC processes operating in comEthernet mode. A CVCC process operating in comEthernet mode will send messages directly to other CVCC processes over the Ethernet. This mode of operation is useful if no SINCGARS radio simulator is available for that process. CVCC processes operating in comEthernet mode are still capable of receiving messages from CVCC processes operating in comRadio mode. The comNone mode supports a special training mode in which the operator is not allowed to send digital messages. Currently, this mode is only used for the CCD. The CCD user interface appears different in this mode and denies the user the ability to send messages. Lastly, the comNoNet option is useful for running a CVCC process (possibly for a demo) on a workstation which is not connected to an Ethernet. If this option is not provided, the CVCC process will terminate upon failure to access the Ethernet driver.

Note that the "-communication" flag followed by a mode name is an alternative way of specifying the communications mode.

-same:	Run with all dialogues on the same screen.
-swap:	Swap the screens used to display dialogues.

These options are used to determine which modules of the CVCC process are displayed on which monitor for a dual-headed workstation. The -same option causes all modules to create windows on the same monitor. Since the CCD currently only uses one monitor, this option has no effect on it. The -swap option is used to switch the monitor which each module is displayed on by default to the other monitor.

-version: Print the current version number and exit.

This option is used to verify that the proper version of software is being used.

Battalion Tactical Operations Center Specific Options

The following options control the mode of execution of the battalion TOC workstations.

Software Switch	Option
-coordinator:	Run as the checkpoint coordinator.

This option is used to start the BnTOC with the checkpoint functionality accessible from the main menubar. Any BnTOC work-station can use this flag, however, traditionally the SitDisp is used as the coordinator.

-develop:	Run in development mode.
-normal:	Run in normal mode.
-nofmt:	Run without the format module.
-notooe:	Run without the TO/OE module.
-nomap:	Run without the map module.
-nomsg:	Run without the message module.
-notools:	Run without the tools.
-notdb:	Run without the terrain.

Each of the above flags is used to run the BnTOC without the specified module. These flags are used to allow the BnTOC to be brought up more quickly and prevent the windows from cluttering the screen during developmental testing. These flags are not supported for normal operations. Running without all modules could cause improper behavior and even failure (crashes) under certain conditions.

Command and Control Display Specific Options:

The following options control the mode of execution of the CCD.

Software Switch	Option
-develop:	Run in custom developmental mode.
-baseline:	Run in baseline mode. Monochrome display, C3 digital comms disabled, touch screen disabled, map functions limited, map features limited to grid lines.
-enhanced:	Run in enhanced baseline mode. Full color display, C3 digital comms disabled, touch screen disabled, map functions limited, Map features limited to grid lines.
-experimental:	Run in experimental mode (DEFAULT MODE). Full color display, C3 digital comms enabled. Touch screen enabled, map fully enabled.

The user should choose a mode in which to run the CCD. Normally, the mode will be set in a resource file, using the *executionMode resource. The "-develop" mode should only be used by developers. Historically, CCD experiments and demos are run using "-experimental" mode, which provides full functionality and display capabilities. The "-baseline" and "-enhanced" baseline modes support alternative levels of restricted functionality.

-innovate:	Innovative training exercise.

The "-innovate" command line switch is used to support a special mode for using the CCD for innovative training exercises.

-color: Overrides mode setting on color setting. Use full color display.
-monochrome: Overrides mode setting on color setting. Use monochrome (amber and black) color display.

By default, the selected CCD mode will determine whether the CCD is displayed in full color or monochrome mode. These command line flags can be used to override the default associated with the mode the CCD will be using.

-mouse: Overrides mode setting on input devices. Enables mouse as input device.
-touch: Overrides mode setting on input devices. Enables touch screen as input device.
-handle: Overrides mode setting on input devices. Enables commander's handle as input device.

By default, the selected CCD mode will determine which input devices will be enabled.

The "-mouse" command line option is used to explicitly enable the mouse as an input device, regardless of the mode.

Similarly, the "-touch" command line option is used to explicitly enable to touch screen. The "-handle" command line option performs the same function for the commander's handle.

-grid: Override mode setting on map features. Display of map features limited to grid lines.
-map: Overrides mode setting on map functions. Map features and map functions fully enabled.

By default, the selected CCD mode will determine which features are displayed by the map, either the full set of map features or just the grid lines. These options are used to override the defaults used by the current CCD mode.

-confine: Confine pointer to CCD/IVIS.

This command line option is used to prevent the cursor on the CCD screen from leaving the window which contains the CCD (and potentially getting "lost" or providing unintended access to workstation functions). This option is normally set using the *pointerConfined resource, and should be used for exercises.

-isolate: Prevent reception of C3 comms from Co networks.

This command line option is used to isolate the CCD from any traffic on the company networks. Other networks are unaffected.

-standalone: Run without vehicle simulator.
-location <UTM locn>: Starting location for our own tank.
-attached: Run with vehicle simulator.

The "-standalone" command line option allows the CCD to operate without a CVCC simulator. This is useful for giving demos of the CCD, since otherwise the "own tank" icon will never appear.

The "-location" command line option is used in conjunction with the "-standalone" option to select the location of the own tank icon. By default, the CCD tries to attach to a vehicle, which may be specified explicitly with the "-attached" command line switch.

-grid: Override mode setting on map features. Display of map features limited to grid lines.

-handle: Overrides mode setting on input devices. Enables commander's handle as input device.

-map: Overrides mode setting on map functions. Map features and map functions fully enabled.

-monochrome: Overrides mode setting on color setting. Use monochrome (amber and black) color display.

-mouse: Overrides mode setting on input devices. Enables mouse as input device.

-location <UTM locn>: Starting location for our own tank.

-normal: Run in experimental mode.

-notdb: Override mode setting on map features. Display of map features limited to grid lines.

-touch: Overrides mode setting on input devices. Enables touch screen as input device.

Miscellaneous CCD Software Switch Options

The following are miscellaneous options.

Software Switch	Option
-confine:	Confine pointer to CCD/IVIS.
-driverport:	Driver Port exists.
-isolate:	Prevent reception of C3 comms from Co networks.
-standalone:	Run without vehicle simulator.

While there are a large number of supported options, not all options should be used by any user of the CVCC processes. Some options will be used routinely during CVCC exercises. Some should only be used in special circumstances. Some options are only useful for developing and debugging. The following sections describe the CVCC process command line options in further detail and describe the appropriate circumstances for their usage.

CVCC SIMULATION STARTUP SWITCHES

The following options are CVCC simulation startup switches.

Software Switch	Option
-a	(asymmetric buffers:receive send)
-A	(Autoloader DISabled
-c	(Override pars file)
-C	(Citv debug)
-d	(debugging on)
-D	(debugging for static vehicles on)
-e	(ethernet off)
-E	(exercise id)
-f	(fail no damage mode on)
-F	(fail debug on)
-g	(graphics off)
-h	(help)
-i	(iff enable)
-l	(laser of citv enabled)
-k	(keyboard on)
-m	(messages for equipment status not printed)
-n	(network verbose mode)
-N	-- show citv icon relative to grid north
-o	(overrun printing)
-p	(position) vehicle_number initial_X initial_Y ini tial_heading
-P	(priority list debugging on)
-r	(rivers all fordable
-s	(stack enable)
-S	(set Network device)

-t	(terrain database) database_name
-T	(ded database) database_name
-v	(verbose mode on)
-V	(CITV DISabled)
-?	(help)

CVCC Simulation Keyboard Switches

The following options are CVCC simulation keyboard switches.

Software Switch	Option
a :	citv_auto_scan ()
A :	print_citv_status ()
c :	set citv_state = OTW_DAY
C :	set citv_state = OTW_OFF
f :	fail_suppress_damages_toggle ()
F :	fail_print_debug_toggle ()
g :	citv_mode_gps ()
G :	citv_mode_citv ()
j :	electsys_battery_failure ()
L :	rva_dump_priority_lists ()
O :	toggle_all_vision_blocks ()
o :	vision_restore_all_blocks ()
p :	rva_turn_debug_on ()
P :	rva_turn_debug_off ()
q :	exit_gracefully ()
Q :	toggle_cmdr_vision_blocks ()
r :	toggle_ldr_vision_block ()
R :	toggle_citv_vision_block ().
s :	citv_search ()
S :	stack_print_info ()
t :	drivetrain_transmission_failure ()
T :	rtc_print_permanent ()
U :	rtc_simul_history ()
v :	print_view_modes ()
V :	rtc_print_time ()
1 :	toggle_dvr_vision_blocks ()
! :	toggle_gps_vision_block ()
2 :	cig_2d_do_init () ()
3 :	disable EO ()
# :	enable EO ()
4 :	sound_reset ()
5 :	fail_cat_kill ()
= :	fuel_tanks_init ()
%% :	fixing everything
[:	network_print_statistics ()
] :	print temperature and power supplies
^ :	loader's periscope left

& :	loader's periscope right
* :	commander's cupola left
(:	commander's cupola right
^ :	toggle gunners vision
& :	toggle drivers vision
? :	Page 1 of help
6 :	Page 2 of help
7 :	Page 3 of help
8 :	Page 4 of help
9 :	Restore ammo
- :	timers_status ()
+ :	print CMC statistics
_ :	zero CMC statistics
; :	send_azimuth
: :	null_azimuth
} :	print and reset bbd rtc statistics
{ :	print bbd rtc statistics
< :	Current <x, y, z>
. :	ammo_print_statistics ()
~ :	print n_mapped value
X :	print_sorted_vehicle_lists ()
0 :	in pivot steer
) :	out of pivot steer
, :	print_reasons ()
/ :	binoculars on
:	binoculars off

SINCGARS Radio Simulation Software.

The following options are SINCGARS Radio simulation commands.

Commands:

network	- network functions
simulation	- simulation status
timing	- timing functions
riu	- RIU functions
jack	- jack functions
fp	- front panel functions
simvads	- simvads functions
hardware	- hardware functions
help	- parser editor help
vehicle	- vehicle functions
radio	- radio state information
version	- print simulator version information
exit	- exit program

RADIO> network

Network Commands:

getstats	- show cmc statistics
zerostats	- zero cmc statistics
ethernetaddress	- display ethernet address
histogram	- network histogram commands
filter	- filter

RADIO> simulation

Simulation Commands:

tickcount	- show tickcount
voicechannel	- show voice channel data

RADIO> timing

Timing Commands:

show	- show timing data
zero	- zero timing data

RADIO> riu

RIU Commands:

show	- show RIU statistics
zerostats	- zero RIU statistics

RADIO> fp

Front Panel Commands:

show	- show front panel state
set	- set front panel parameter

RADIO> simvads

SIMVADs Commands:

show	- show simvad statistics
zero	- zero simvad statistics

RADIO> hardware

Hardware Commands:

resetsimvads	- reset ALL simvad cards
simstats	- show statistics for simvads
resetfrontpanels	- reset ALL front panels

RADIO> simvads

SIMVADs Commands:

show	- show simvad statistics
zero	- zero simvad statistics

RADIO> hardware

Hardware Commands:

resetsimvads	- reset ALL simvad cards
simstats	- show statistics for simvads

resetfrontpanels - reset ALL front panels

RADIO> vehicle

Vehicle Commands:

showposition - show position of vehicles

setposition - set position of vehicle for given radio

RADIO> radio

Radio Commands:

showlocal - show local radio state

showremote - show remote radio state

RADIO> version

Radio Simulator Version = Knox v2.2 Thu Jun 4 14:24:10 EDT 1992

Connecting Simulated SINCGARS Radios to TOC Workstations

Configuring simulated SINCGARS radios to connect to BnTOC workstations is similar to that which is done for standalone CCD systems. There are three parameter file keywords of interest: attach, ccd and riu. An in-depth explanation of these keywords appears in the SINCGARS Simulation Reference provided to each technician at CCTB.

attach

For a BnTOC workstation, the radio simulation is configured to generate vehicle appearance PDU's for a vehicle (currently an M577) housing the radio. The "nothing" variation of the attach keyword is used. It is of the form:

attach <rnum> nothing <vnum> (<xloc> <yloc>)

where: <rnum> is the number used internally to identify the simulated radio (assigned with the "radio" keyword.)

<vnum> is the vehicle number (prepended with the site/host pair of the radio simulation host to produce a vehicle ID.)

(<xloc>,<yloc>) is the location of the vehicle on the terrain.

example: attach 2 nothing 101 (40000, 40000)

causes the radio simulation software to issue vehicle appearance PDU's for an M577 at location (40000, 40000), and to calculate propagation loss for radio 2 at this location.

It is recommended that each radio be assigned a separate vehicle, and that each vehicle be situation at least 20 meters from its neighbors. Note that the only way to modify location is to change the parameter file entry and restart the simulation software. It was anticipated that a separate "BnTOC vehicle simulator" would be developed, and the vehicle generation facility of the SINCGARS software was only to be an interim solution, hence limited cap- ability.

ccd

BnTOC workstations use the CCD simulation protocol. Consequently, the radio simulation is configured to treat each BnTOC as a standalone CCD.

The appropriate form is:

ccd <inum> <site>/<host>
where:

<inum> is the number used internally by the SINCGARS simulation to identify this CCD/BnTOC.
<site>/<host> is the site/host pair for the BnTOC simulation host.

example: ccd 1 3/50

designates the BnTOC simulated by host 3/50 as CCD number 1.

riu

The riu keyword maps radios to CCD/BnTOC systems.

The proper form is:

riu <rnum> <# radios> {<r1> <r2> ...} <#ccd's> {<i1> <i2> ...}

where:

<rnum> is the internally-used number of the RIU (used in the keyboard parser for query and control).
<# radios> is the number of simulation radios assigned to this RIU (1 or 2).
<r1> <r2> are the identifying numbers of the simulated radios (configured with the radio keyword) assigned to this RIU.
<# ccd's> is the number of simulated CCD/BnTOC systems assigned to this RIU (typically 1).
<i1> <i2> are the identifying numbers of the simulated CCD/BnTOC systems assigned to this RIU, as configured with the CCD keyword.

example: riu 1 1 2 1 1

assigns RIU 1 to connect one radio, number 2, to one CCD, number 1.

CVCC Simulation Listen Program Switches.

Following are the Listen Program Switches.

CVCC-Listen <exercise id>... [options]
Where the options are:

Software Switch	Option
	=> reports and routes <=
adjust	adjust fire reports
cff	call for fire reports
contact	contact reports
freetext	free text reports
intel	intel reports
nbc	nbc reports
route	ivis routes
shell	shell reports
sit	situation reports
spot	spot reports
all	all reports and ivis routes
	=> info messages <=
status	ivis vehicle status information packets
tasking	task organization information
bnutm	bntoc utm location
sitdisp	commands to the situation display
allinfo	all info messages
	(NOTE: Requesting tasking, bnutm or sitdisp will turn all three of these options on.)
	=> execution control <=
exec	execution control messages (checkpoint and shutdown)
	=> citv packets <=
citvo	citv orientation
citvi	citv instrumentation
	=> overlays <=
overlay	an overlay control message (begin and end overlay)
point	an overlay point symbol
poly	an overlay poly line
mostext	overlay text
mosdb	mos link to a database object
mosall	all overlay packets

	=> ivis instrumentation <=
iirg	ivis report generation instrumentation
iimsg	ivis message instrumentation
iimap	ivis map instrumentation
iiqty	ivis quantity instrumentation
iiall	all ivis instrumentation
	=> bntoc instrumentation <=
bimsg	bntoc message instrumentation
bifldr	bntoc folder instrumentation
bimap	bntoc map state and overlay instrumentation
biall	all bntoc instrumentation
CVCC-	=> for innovative training <=
innotr	displays innovative training packets
	=> for debugging communication with sincgars radio <=
sincgars	displays transmit respond and receive packets
	=> simulator packets of interest <=
vap	vehicle appearance packets
laser	laser range finder packets
vstat	vehicle status packets
	=> everything!! <=
allmsg	all cvcc messages (object and info)
allcvcc	all cvcc packets (object and info)
everything	all packets pertinent to cvcc

To choose the option, precede the option name with a '+'.
To remove the option, precede the option name with a '-'.

The default for CVCC-Listen is all ivis reports and routes.

<u>CVCC Simulation Semi-Automated Forces(SAFOR)Program Switches and Commands</u>.

Following are the SAFOR Program Switches and Commands.

Switches:	Options
-c	(cache terrain to speed startup)
-d	(debugging on)
-e	(exercise id) #
-i	(isolate connection) #
-n	(no network packets sent)
-p	(phantom commands debugging on)

-s	(sleep occasionally to allow workstation on same machine)
-t	(terrain dbase to use) filename
-v	(vehicle projector mode)
-? or -h	(print help)
-6	(version 6.0 simnet constants)
-2	(Ethernet 2 packets [not 802.3])
-z	(Restore the terminal after a program crash, and exit)
-o	(record fire data to file firedata)

<u>Software Command</u>

PHANTOM @ ASHLAND>
Commands:

blaster	- blast a ton of vehicles
checkpoint	- send a checkpoint message to front end
create	- create an echelon
console	- send a console message
debug	- debugging operations
exit	- exit program
hashing	- simnet id hashing statistics
heap	- heap operations
net	- network commands
print	- print commands
quit	- exit program
reset	- global phantom reset : **USE WITH CAUTION**
message	- send a message to the Symbolics screen
set	- set program parameters
stealth	- stealth operations
vehicle	- vehicle operationsblaster?

PHANTOM @ ASHLAND> blaster [how many platoons (4 vehicles) (Expecting a decimal number)]

PHANTOM @ ASHLAND> checkpoint [file name to use (Expecting a string)]

PHANTOM @ ASHLAND> create

blue	- US
red	- USSR

PHANTOM @ ASHLAND> console [type in message in quotes...(Expecting a string)]

PHANTOM @ ASHLAND> hashing
Options for the hashing command:

collect	- start collecting id hashing statistics
report	- report collected id hashing statistics

```
PHANTOM @ ASHLAND> heap
    Options for the heap command:
collect              - force a collect on a heap
statistics           - print statistics for a heap
verify               - verify the consistency of a heap

PHANTOM @ ASHLAND> net
    Options for the net command:
stats                - print simnet statistics
zero                 - zero out the simnet statistics
thresholding         - get thresholding statistics

PHANTOM @ ASHLAND> print
    Options for the print command:
buffers              - number of buffers allocated
connections          - connection status
count                - count of vehicles in simnet
exercise             - exercise that this phantom is running in
hosts                - count of vehicles by hosts
forces               - count of vehicles by force
overlays             - overlays
reactions            - reactionary CISes
sites                - count of vehicles by site
vehicles             - id's of current vehicles
version              - version of phantom program

PHANTOM @ ASHLAND> reset
    Please confirm...: yes  - Reset the phantom (WARNING: THIS CLEARS EVERY
        THING)
                       no   - Abort reset operation

PHANTOM @ ASHLAND> message [Message to send (Expecting a string)]

PHANTOM @ ASHLAND> set
   Options for the set command:
command_printing       - printing of SBX commands on/off
abort_on_error         - if on error checks will call abort
print_prot_err         - if protocol version error will report it
nan_abort              - if FP PROC gets an exception, will
                       abort (ON)
ground_impact_mode     - display of ground impacts on/off
header_printing        - printing of SBX headers on/off
indirect_fire_mode     - display of indirect fire on/off
monitor_period         - period for scheduler monitor
tree-avoidance         - are ground vehicles allowed to avoid
                       trees on/off
checkpoint             - will CVCC checkpoint messages be processed,
                       on/off
```

PHANTOM @ ASHLAND > stealth

Options for the stealth:

set_tick	- set time in seconds for symbolics drawing of stealth
address	- set site host pair for stealth to talk to
teleport	- send stealth to specified x y location
attach_to	- attach stealth to specified vehicle
exercise	- change stealth's exercise to specified number
mimic	- mode for stealth, attach or mimic(default)

PHANTOM @ ASHLAND > vehicle [vehicle id (Expecting a decimal number)]

<u>SemiAutomated Forces CVCC Message Default Parameters</u>.

The following are default parameters which may be used to configure the way in which the CVCC BLUFOR tanks and scouts report their battlefield locations and combat actions using CVCC message formats. (Program Revision 1.1.2.1)

BLUFOR IVIS (CVCC) Reporting
<u>Parameters</u>
(default_cluster_distance *1000.0*[1])
(default_decluster_distance *1200.0*)
(default_spot_rep_range_threshold *1000.0*)
(default_max_reappear_latency *600000*) ;;; (10*60*1000)
(default_shell_range_threshold *1000.0*)
(default_shell_distance *1000.0*)
(default_shell_latency *300000*) ;;; (5*60*1000)
(default_report_monitor_time *20000*) ;;; (2*1000) no longer used
(default_ivis_status_interval *5000*) ;;; (5*1000)
(default_under_attack_time_threshold *90000*) ;;; (90*1000)
(default_shooting_range_threshold *1800.0*)
;;; default values for amount of time in msec it takes to prepare an ivis report -
;;; there are times for each report type and an added amount for attack
(default_af_prepare_time *60000*) ;;; (seconds*1000)
(default_ammo_prepare_time *300000*)
(default_cff_prepare_time *60000*)
(default_contact_prepare_time *15000*)
(default_shell_prepare_time *60000*)
(default_sitrep_prepare_time *180000*)
(default_spot_prepare_time *60000*)
(default_intel_prepare_time *300000*)
(default_frago_prepare_time *300000*)
(default_nbc_prepare_time *300000*)

[1] Numbers shown in *italics* are current default settings on the CVCC network in the MWTB.

```
(default_attack_prepare_time 300000)
    ;;; constraint on amount of time in msec between reports
(default_platoon_time_constraint 30000)
(default_company_time_constraint 45000)
(default_contact_range_threshold 750.0)
(default_contact_timer 180000) ;;; (3*60*1000)
    ;;; Default values for relative priority of the various type report types.
    ;;; It is assumed that there are 10 report types.
    ;;; 0 is most important, 9 is least important.
    ;;; No two report types are allowed to have the same priority value.
    ;;; A priority of 10 (numberReportTypes) indicates unknown priority and will cause reports of that type to be ignored.
    ;;; There are currently 7 valid report types so must have all values between and including 0 thru 6 with others set to 10.
(default_contact priority 0[2])
(default_spot_priority 1)
(default_cff_priority 2)
(default_af_priority 3)
(default_shell_priority 4)
(default_ammo_priority 5)
(default_sitrep_priority 6)
(default_intel_priority 10)
(default_frago_priority 10)
(default_nbc_priority 10)
    ;;; Default values for relative priority of the various vehicle types.
    ;;; It is assumed that there are 9 legal vehicle types.
    ;;; A bigger value for priority indicates increasing importance.
    ;;; The overall priority indicates increasing importance.
    ;;; The overall priority of a cluster is computed as sum over i of the number of vehicles of type i times the priority weight for vehicle type i.
(default_unk_pri_weight 5[3])
(default_tank_pri_weight 5)
(default_atgm_pri_weight 5)
(default_rwa_pri_weight 5)
(default_fwa_pri_weight 5)
(default_arty_pri_weight 5)
(default_pc_pri_weight 5)
(default_truck_pri_weight 5)
(default_troop_pri_weight 5)
```

[2] See Footnote Nr 1.

[3] See Footnote Nr 1.

APPENDIX E

CVCC OPEN PROGRAM ERRORS

REPORTED BUGS
in the
COMBAT VEHICLE COMMAND and CONTROL
(CVCC)
PROGRAMS

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17 December 1992

FOREWORD

The Army Research Institute's (ARI) Fort Knox Field Unit in conjunction with the Tank Automotive Command RD&E Center's Vetronics Division, has been working with US Army Armor center personnel and a team of contractors in the Close Combat Test Bed facility to develop an operational, futuristic, state of the art command, control, and communication test bed at Fort Knox. The CVCC test bed has supported platoon to battalion level evaluations of both vehicle and Tactical Operations Center (TOC) soldier performance requirements. Determining these soldier performance requirements is essential to the development of fightable systems.

This document is intended to provide a listing of those faults in the Combat Vehicle Command and Control software, which was utilized in the series of evaluations, which were conducted during the period FY 1989 thru FY 1993, that remain uncorrected in the event other agencies may desire to utilize all or portions of the software for future evaluations. Although many faults discovered during the ARI evaluations were corrected a significant number were set aside since they:

(1) Were determined to be not critical to the CVCC evaluations.

(2) Were discovered so late in the evaluation program that time/funds were not available to permit the changes to be made.

(3) Were determined to have satisfactory work-arounds consequently the fault was assigned allow priority for correction.

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Reported Bugs
for the
CVCC Evaluation Program

General

1. Following is a listing of bugs which have been reported and have not yet been corrected during the CVCC evaluation program to date.

2. The format used in reporting is an adaptation of the format used during the evaluation period to track reported bugs. An explanation of the format follows:

ID:	This is an identification number assigned to track the reported bug. The number shown here is a cross reference to the master Change/Bug list.
Type:	Identifies the reported bug.
Status:	Provides the status correction of the item.
Pri:	States the priority previously assigned to the item through FY 92.
Opened:	The date the bug was reported.
Est:	The engineer time (in person-days) that it is estimated it will take to correct the bug.
Closed:	The date the supervising engineer reports that bug is corrected.
Sys:	The CVCC subsystem in which bug correction is required. (e.g. TOC)
Mod:	The module of the subsystem in which the bug correction is to be made. (e.g. Overlay module of TOC WS).
Short:	A short hand descriptor of the bug.
Description:	A fuller description and explanation of the bug to assist the engineers to better understand what is desired or what is the required action.

Note: Not all format items will appear with each item.

3. The bug listing following is separated by the major CVCC systems:

a. The Tactical Operations Center (TOC).

ID:	082
Type:	Bug
Status:	Open (suspended)
Opened:	90/11/28
Sys:	TOC
Mod:	Motif
Description:	At random times, the map scrollbars do not properly track the cursor; it must be carefully moved and released within the slider area for a panning operation to complete.
Disposition:	This is a bug in Motif. We'll keep an eye out for a fix from ICS.

ID: 084
Type: Bug
Status: Open
Pri: 3
Opened: 90/11/28
Est: 1
Closed:
Sys: TOC
Mod: msg
Short: Multiple routers for 1 msg.
Description: Multiple Route dialogues may be created for the same folder viewer.

ID: 105
Type: Bug
Status: Believed fixed - Reopened 11/21/91
Pri: 2
Opened: 91/01/14
Est: mtf
Closed:
Sys: TOC
Mod: Motif
Short: "Losing Pointer" problem.
Description: BnTOC W/S mouse pointer stops working. Pointer tracks only on one display, disappearing when the edge of that display is reached and reappearing on the opposite side of the tracked display if the mouse continues to be moved. No menus, buttons or other BnTOC widgets operate when this happens. The BnTOC process must be killed from another workstation.

Reopened: The rare but infamous "Losing Pointer Problem" occurred once. The pointer was stuck on one monitor and the pointer would eventually wrap around to the other side of the same monitor. BnTOC had to be killed from another node (as always whenever this happens). This is a "Motif" problem.

ID: 119
Type: Bug
Pri: 2
Opened: 91/01/14
Status: Open (deferred)
Est: 5
Closed:
Sys: TOC
Mod: msg
Short: Local db info wrong for remote msgs.
Description: The Action Taken and Comments fields in remote viewers are incorrect. They show the Action Taken and Comments from the messages stored on the local machine instead of the remote machine. These fields should not be present on remote viewers.

ID: 221
Type: Bug
Status: Open (deferred)
Pri: N/A
Opened: 91/03/27
Est:
Closed:
Sys: TOC
Mod: msg
Short: User error while filling in FLOT loc.
Description: SitRep report received from IVIS only posted one FLOT location to map even though both were filled in.

ID: 226
Type: Bug
Status: Open (deferred)
Pri: 2
Opened: 91/03/27
Est: ?
Closed:
Sys: TOC
Mod: map
Short: Objects disappear when map scaled.
Description: During the creation of one overlay, objects which were created disappeared when the map was scaled while still in edit mode. Bev witnessed this edit session. Subsequent to this session,however, we could not reproduce the problem.
Disposition: Deferred due to non-recurrence.

ID: 245
Type: Bug
Status: Open
Pri: 2
Opened: 91/16/09
Est: mtf
Closed:
Sys: TOC
Mod: Motif
Short: Map Scroll Bars don't work properly.
Description: Fix Scroll Bars. They don't work properly. Before the map will scroll, the bar has to be moved in the intended direction and then back just a "smidgeon".

ID: 267
Type: Bug
Status: Open
Pri: 3

Opened:	91/11/21
Est:	?
Closed:	
Sys:	TOC
Mod:	Motif
Short:	Eliminate Motif defaults.
Description:	The new R4 Motif "default" outlines are very annoying. In addition to being ugly, they cause the return key to behave differently under different conditions. They are also confusing in the case the outlined field is different from the highlighted field in a message composer. Can we disable this "feature"? Also, there is an annoying default border around a list item, which is also unuseful and confusing.

ID:	269
Type:	Bug
Status:	Open
Pri:	3
Opened:	91/11/21
Est:	mtf
Closed:	
Sys:	TOC
Mod:	Motif
Short:	Msg fields lose first char.
Description:	When the user tabs to a new field in a message composer (instead of clicking with the pointer into the field), the test field subsequently looses the first character.

ID:	281
Type:	Bug
Status:	Open
Pri:	3
Opened:	91/11/21
Est:	2
Closed:	
Sys:	TOC
Mod:	all
Short:	Cursor loc inconsistent in popups.
Description:	The acknowledgement popups are not consistent in terms of the cursor being positioned in the default button. Sometimes it is placed there, other times it is just moved into the popup.

ID:	288
Type:	Bug
Status:	Open
Pri:	3
Opened:	91/11/21

Est:	?
Closed:	
Sys:	TOC
Mod:	X
Short:	Some icons asymmetrical.
Description:	Icons weren't all symmetrical in appearance. This appears to be a problem with the Sun X server, as they appear correctly on other machines.

ID:	289
Type:	Bug
Status:	Open
Pri:	3
Opened:	91/11/21
Est:	1
Closed:	
Sys:	TOC
Mod:	graph
Short:	Object labels not unique.
Description:	Object labels are not tested for uniqueness. Should they be? Is this a resource?

ID:	399
Type:	Duplicates (see #245)
Status:	Open
Opened:	91/12/05
Est:	
Closed:	
Pri:	3
Sys:	TOC
Mod:	map
Short:	Scroll bar is unpredictable
Description:	Distance operator moves bar is not proportional to distance map scrolls.

ID:	446
Type:	Bug
Status:	Open
Opened:	92/05/21
Est:	5
Closed:	
Pri:	3
Sys:	BnTOC
Mod:	format
Short:	Format module needs instrumentation and checkpoint/recovery
Description:	Currently, neither checkpoint/recovery or instrumentation is implemented for the format module. The following in proposed for format instrumentation. The BnTOC instrumentation structure will get one more kind - format event instrumentation. The format structure will contain two fields and a union.

The two fields are the format event and a format id. The format id will contain the role of the host, the format type, and the format name. The union is for copy events which will contain the source and destination format id's. The event field represents the following events - create, open, delete, copy, save and close.

ID:	457
Type:	Bug
Status:	Open (can't reproduce)
Opened:	92/07/09
Est:	1
Closed:	
Pri:	2
Sys:	BnTOC
Mod:	message mgr
Short:	Invalid highlighting in folders
Description:	Sometimes there is a "hanging" highlight in the inbox. If all the messages in the inbox are deleted, the next message that comes in will be highlighted. When the "selected" button is pressed, a "select message first" alert comes up.

ID:	506
Type:	Bug (motif problems)
Status:	Open
Opened:	92/09/15
Est:	??
Closed:	
Pri:	??
Sys:	BnTOC
Mod:	message
Short:	Message viewers have problems
Description:	Message viewers sometimes do not get built correctly. Occasionally message viewers do not get built correctly, and buttons or fields are missized, or absent. Portions of message viewers are drawn off the screen on the BnTOC Ws. If the top of the viewer is off the screen the message cannot be moved. Close button sometimes does not appear on messages viewed on the BnTOC WS map display. The only way to close this is to use the middle mouse button on the title bar. This causes a menu to appear. Portions of the create format dialog box remain after the message has been created, edited and closed. Minimizing the format module and then selecting maximize get rid of this. All buttons and fields do not always appear on the BnTOC WS copy dialog box. Occasionally, when clicking on the copy overlay button on the copy dialog box, the cursor went to top of the display, and the ws locked up.

ID:	516
Type:	Bug
Status:	Open (workaround)
Opened:	92/09/15

Est:	1
Closed:	
Pri:	1
Sys:	BnTOC
Mod:	window manager
Short:	Window manager disappears
Description:	Occasionally the window manager disappears on the right hand monitor of the TOC ws. Restarting the window manager and toc program is a workaround.

ID:	527
Type:	Bug
Status:	Open
Opened:	92/09/18
Est:	3
Closed:	
Pri:	1
Sys:	BnTOC
Mod:	msg aggregation
Short:	Incorrect shell report aggregation
Description:	Components are as follows:

#	Loc	Time	From
-	---	----	---
30	ES93168564	16 1530:28	C21
28	ES93188560	16 1530:28	C11
19	ES93268562	16 1530:28	C31

The aggregate reported location unknown, and the # in the tens of thousands.

ID:	528
Type:	Bug
Status:	Open
Opened:	92/09/18
Est:	5
Closed:	
Pri:	1
Sys:	BnTOC
Mod:	sit disp
Short:	Sometimes overlays don't post
Description:	Usually, overlays post to the situation display just fine. Occasional, something gets out of whack, and every attempt to post produces a popup dialog on the sitdisp saying the "file <name> can't be found." Looking in the sitdisp's overlay directory, sure enough, the file isn't there. Diagnostic software was added so if the system command which copies the file fails, it will print out a message as to what command failed, and what the return code is. No actions until problem is reproduced. Once this problem occurs, nobody can post an overlay to the situation display. Taking the BnTOC down and starting it up in -recover fixes the problem.

ID:	530
Type:	Bug
Status:	Open
Opened:	92/09/15
Est:	1
Closed:	
Pri:	3
Sys:	BnTOC
Mod:	folder
Short:	Watch cursor doesn't turn on
Description:	Code was added to flush the event queue of button events when there is a long wait. To signify that this is a "no button event" time, a watch cursor is displayed. For many of the folder contexts, the watch cursor just doesn't turn on. It does enter the code (confirmed with the debugger and printf's), but the cursor never changes.

ID:	532
Type:	Bug
Status:	Open
Opened:	92/09/15
Est:	3
Closed:	
Pri:	1
Sys:	BnTOC
Mod:	overlay text
Short:	Text gets hosed
Description:	On occasion, with a lot of stack manipulation, the text for the entire stack of overlays gets hosed. This has been seen a number of times, but cannot be reliably reproduced.

b. Command and Control Display. (CCD)

ID:	417
Type:	Bug
Status:	Open
Opened:	92/04/21
Est:	2
Closed:	
Pri:	3
Sys:	IVIS
Mod:	map
Short:	Selection by arrows doesn't work
Description:	This is verified for friendly aggregation. Since arrows don't work at all for report icons, it's unknown if this bug exists for report icons as well. When a de/aggregation occurs such that an arrow is produced, the user should be able to select the arrow to perform a de/aggregation function on it. At this time,

nothing happens when a de/aggregation arrow is selected. Selection of reports by arrows _do_ work.

ID: 476
Type: Bug
Status: Open
Opened: 92/07/09
Est:
Closed:
Pri: 3
Sys: IVIS and BnTOC
Mod: graphics
Short: Abati symbol is wrong
Description: The abati obstacle is not correct; the actual symbol is a repeated series of the individual symbol currently displayed.

ID: 481
Type: Bug
Status: Open
Opened: 92/07/09
Est:
Closed:
Pri: 1
Sys: IVIS and BnTOC
Mod: fire support
Short: More symbols than trp's are fire support symbols
Description: There are other symbols that qualify as fire support symbols.

ID: 504
Type: Bug
Status: Open
Opened: 92/09/15
Est: 5
Closed:
Pri: 2
Sys: ccd
Mod: friendly aggregation
Short: BnTOC ws stops updating friendly icons
Description: BnTOC ws unexpectedly stops updating POSNAV icons until the program is stopped and restarted (recovered). Some more anomalous (perhaps with common route to this problem) observed by BIS (as reported in a note to cjr): A rather peculiar aggregation bug has shown up. It is intermittent and non-deterministic (our favorite kind). This strange behavior shows up with sections and companies. Vehicles, platoons, and the battalion are all displayed correctly. For some reason, sometimes a company headquarters section is placed at the upper left hand corner of the map. Scrolling the map does not move the unit onto the screen - it stays perched in that upper left

corner. One of the members of the section will be shown as an outlier in its proper position. The section is placed in the upper left corner. The section can be selected, and deaggregated to vehicles. Both vehicles will be displayed correctly. The company that owns the section will also show up in the upper left corner. When its selected, all of its descendants, except the headquarters section, will be displayed correctly. If everything is aggregated into a battalion, the battalion is placed correctly. Here's the weird part. There are 5 BnTOC's running. Right now, 2 of them are showing this anomalous behavior with company A. Earlier, only one BnTOC showed this problem with company C. To fix it, the BnTOC is brought down and brought back up in recover mode. The problem goes away.

ID:	529
Type:	Bug
Status:	Open
Opened:	92/09/18
Est:	1
Closed:	
Pri:	1
Sys:	ccd
Mod:	posted icons
Short:	FLOTs from the sitdisp can't be selected for unpost
Description:	For one particular sitrep FLOT, the icon could not be selected for unposting. Even selecting "all" in the unpost menu would not remove the icon. The icon did highlight for both selection methods, but did not go away when the "unpost" button was pressed.

c. CVCC Simulators.

ID:	361
Type:	Bug
Status:	Open
Opened:	91/12/05
Est:	?
Closed:	
Pri:	1
Sys:	SIMS
Short:	Random firings with no operator input
Description:	Random firings with no operator input (not simply anomalous sounds). A couple of confirmed cases of fratricide resulted (observed on BLUFOR workstation).

ID:	362
Type:	Bug
Status:	Open
Opened:	91/12/05
Est:	?

Closed:
Pri: 1
Sys: SIMS
Short: Missing/intermit veh images in driver's vision blocks.
Description: Missing or intermittent vehicle images in driver's and loader's vision blocks. Not true bug (?) but serious problem occasionally resulting in collisions. Attributed to overloaded CIG.

ID: 363
Type: Bug
Status: Open
Opened: 91/12/05
Est: ?
Closed:
Pri: 1
Sys: SIMS
Short: One of driver's vision blocks sometimes lapsed blank.
Description: One of driver's vision blocks sometimes lapsed blank and neutral steering moved blank to next vision block.

ID: 364
Type: Bug
Status: Open
Opened: 91/12/05
Est: ?
Closed:
Pri: 1
Sys: SIMS
Short: Bushes appear as white balls or black boxes in vision blocks.
Description:

ID: 365
Type: Bug
Status: Open
Opened: 91/12/05
Est: ?
Closed:
Pri: 1
Sys: SIMS
Short: CITV and gun tube drift after gun slews from Designate.
Description: CITV and gun tube drift after gun slews from Designate (overshoot?). Greater slew arc produces greater drift. Comment from General Heiden: "I have tried to duplicate this and have not been able to cause this to happen. It may be a HW problem related to the traverse handle adjustment."

ID: 366

Type:	Bug
Status:	Open
Opened:	91/12/05
Est:	?
Closed:	
Pri:	1
Sys:	SIMS
Short:	Sim resupply ("9" key) resupplies 55 instead of 40 rounds.
Description:	Pressing "9" on back of sim keyboard resupplies 55-round ammo load, should be modified to 40-round load

ID:	367
Type:	Bug
Status:	Open
Opened:	91/12/05
Est:	?
Closed:	
Pri:	1
Sys:	SIMS
Short:	One quadrant of CITV display occasionally lapsed blank.
Description:	One quadrant of CITV display occasionally lapsed blank (green with no terrain features).

ID:	368
Type:	Bug
Status:	Open
Opened:	91/12/05
Est:	5
Closed:	
Pri:	1
Sys:	SIMS
Short:	CITV initialized to out the window view.
Description:	When the simulation is initialized, the CITV occasionally comes up in out the window view. Pushing the white hot/black hot switch enables the thermal view.

ID:	377
Type:	Bug
Status:	Open
Pri:	2
Opened:	91/12/05
Est:	?
Closed:	
Sys:	SIMS
Short:	Simulator reconstitution: The 2D portion of the CITV
Description:	Simulator reconstitution: The 2D portion of the CITV does not always display correctly after a reconstitution of the simulator. The CIG needs to

be reset before each reconstitution.

ID:	378
Type:	Bug
Status:	Open
Opened:	91/12/05
Pri:	1
Est:	20? days
Closed:	
Sys:	SIMS
Short:	Simulation hangs up.
Description:	For no apparent reason, the simulation stops. The views are still present, but they do not update. The simulation terminal gives no indication as to what has happened except that it is also hung up. Observation: The CIG needs to be reset a couple of times after this condition in order for the boot process to pass the point of "installing rst4". Disposition: NB: tell the techs to reset the BCS 1 bus first. Difficult to estimate unless we know how often this happens.

ID:	379
Type:	Bug (see #363)
Status:	Open
Pri:	1
Opened:	91/12/05
Est:	20? days
Closed:	
Sys:	SIMS
Short:	Vehicles are not seen from several simulators.
Description:	Vehicles disappearing: vehicles are not seen from several sims (4B, 3B, 2B). Simulator vehicles will occasionally drop out or pop in and out. This appears to happen to only the sims and not MCC generated vehicles (targets, etc.)
Disposition:	If there are fewer than 60 vehicles, than this will require a lot of investigation.

ID:	380
Type:	Bug
Status:	Open
Pri:	1
Opened:	91/12/05
Est:	?
Closed:	
Sys:	SIMS
Mod:	sound
Short:	No sounds: For no apparent reason, all sounds drop out.
Description:	
Disposition:	Known problem with Perc sound system.

ID: 381
Type: Bug
Status: Open
Pri: 1
Opened: 91/12/05
Est: 20
Closed:
Sys: SIMS
Short: Partial sounds: Some sounds are heard but others are not.
Description:

ID: 382
Type: Bug (see #381)
Status: Open
Pri: 1
Opened: 91/12/05
Est:
Closed:
Sys: SIMS
Short: Continuous sounds
Description: When the vehicle is turned off, the track movement sound continues. The slew sound continues even though slewing has stopped.

ID: 383
Type: Bug (See ID: 361)
Status: Open
Pri: 2
Opened: 91/12/05
Est: ?
Closed:
Sys: SIMS
Short: Anomalous sounds: When the vehicle steering bar is rotated
Description: Anomalous sounds: When the vehicle steering bar is rotated, a gun firing sound is heard.

d. MCC.

ID: 388
Type: Bug
Status: Open
Pri: 3
Opened: 91/12/05
Est: ?
Closed:
Sys: MCC

Short: Defense option invalid
Description: Upon startup of the SCC, the MCC can be set to place all vehicles as defense. Even though this is done, the defense option must still be selected at each reconstitution screen because the observer option will be selected each time.

e. SINCGARS.

ID: 488
Type: Bug
Status: Open
Opened: 92/07/09
Est: ??
Closed:
Pri: 1
Sys: sincgars
Mod:
Short: Performance in sincgars is lacking
Description: An 240 packet overlay takes 8 minutes 27 seconds to transmit using riu mode; it takes less than 3 seconds in broadcast mode. A message is transmitted almost instantaneously in broadcast mode; it takes about 2.1 seconds using the riu.

f. SEND Utility.

ID: 499
Type: Bug
Status: Open
Opened: 92/08/06
Est: 1
Closed:
Pri: 3
Sys: send
Mod: send
Short: Field value keywords can't have trailing whitespace.
Description: This limitation relates to the parsing of field value entries (keywords). Most lines in a Send file follow the format: "Field_Name field_value" If any characters are entered on the line after the field_value, the input is not accepted. This is true even if the extra characters are invisible whitespace, such as space or tab characters. In other words, a carriage return must immediately follow the field_value.

ID: 500
Type: Bug
Status: Open

Opened:	92/08/06
Est:	1
Closed:	
Pri:	3
Sys:	send
Mod:	send
Short:	Single-line text fields require <CR>.
Description:	This limitation relates to the parsing of single-line text fields. Text fields include all Text, FreeText, and Rationale fields. A single-line text field follows the format: Field_Name Here's some short text. The limitation is that a carriage return MUST follow the end of the text. However, since text fields are always last in a Send file, it is easy to forget to add the final carriage return. Further, the file will appear complete, since the final carriage return is not visible.

ID:	533
Type:	Bug
Status:	Open
Opened:	92/09/15
Est:	1
Closed:	
Pri:	2
Sys:	send
Mod:	intel reports
Short:	Obstacle unknown gets wrong constant
Description:	If a user does not specify what an obstacle is, obstacle->what gets set to SP_IvisTargetTypeUnknown rather than SP_IvisObstacleTypeUnknown

APPENDIX F

CHANGE REQUESTS PENDING FOR THE COMBAT VEHICLE COMMAND AND CONTROL (CVCC) PROGRAM

CHANGE REQUESTS PENDING
for the
COMBAT VEHICLE COMMAND and CONTROL
(CVCC)
PROGRAM

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17 December 1992

FOREWORD

The Army Research Institute's (ARI) Fort Knox Field Unit in conjunction with the Tank Automotive Command RD&E Center's Vetronics Division, has been working with US Army Armor center personnel and a team of contractors in the Close Combat Test Bed facility to develop an operational, futuristic, state of the art command, control, and communication test bed at Fort Knox. The CVCC test bed has supported platoon to battalion level evaluations of both vehicle and Tactical Operations Center (TOC) soldier performance requirements. Determining these soldier performance requirements is essential to the development of fightable systems.

This document is intended to provide a listing of the unimplemented changes which were identified as possible improvements in the Combat Vehicle Command and Control software which was utilized in the series of evaluations conducted during the period FY 1989 thru FY 1993 in the event other agencies may desire to utilize all or portions of the software for future evaluations. Although many changes suggested during the ARI evaluations were implemented a significant number were set aside since they:

(1) Were determined to be not critical to the CVCC evaluations.

(2) Were discovered so late in the evaluation program that time/funds were not available to permit the changes to be made.

(3) Were desirable but were assigned a low priority for correction.

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Change Requests Pending
12/03/90 thru 10/08/92

1. Following is a listing of changes which have been requested, but not yet implemented for the CVCC evaluation program to date. Not included in the listing are features which have been defined in the functional descriptions for the various components being utilized in the evaluation; these will be the subject of a separate paper. The format used is an adaptation of the format used during the evaluation period to track changes requested by both ARI sponsors and by the contractor personnel responsible for the formative evaluations.

ID:	This is an identification number assigned to track the requested change. The number shown is a cross reference to the master change/bug list.
Type:	Identifies whether the item is a change request or a reported bug (all items on this list are change requests.
Status:	Provides the status of implementation of the item.
Pri:	States the priority previously assigned to the item through FY 92.
Opened:	When known, The date the change was requested.
Est:	When known, the engineer time (in person-days) that it is estimated it will take to implement the change.
Closed:	The date the supervising engineer reports that the change is implemented.
Sys:	The CVCC subsystem in which the change is to be made. (e.g.: TOC, CITV, etc.).
Mod:	The module of the subsystem in which the change is to be made. (e.g.: Overlay, Format, etc.).
Short:	A short hand description of the change.
Description:	A fuller description and explanation of the change to assist the engineers to better understand what is desired or what is the required action.

^*Note: Not all format items will appear with each item.*

2. The listing following is separated by major CVCC subsystems and modules.

a. The Tactical Operations Center (TOC).

ID:	050
Type:	Change Request
Status:	Open
Pri:	3
Opened:	91/03/18
Est:	4
Closed:	
Sys:	TOC
Mod:	All
Short:	Popup dialogues popdown inconsistent.

Description: There is an operational inconsistency between the Folder Viewer and Map Modules. Operations like Send Overlay allow the dialog to remain active for multiple sends, while operations like Copy/Post cause the dialog to pop down. Gen Heiden says that the SEND operations should all cause the router dialog to pop down after pressing SEND. 3/18/91 Fran says: "I think that there are more reasons for explicit closing of the box than not, so then, all boxes should require an explicit closing. That inconvenience is far less than would be required by having to open the box again to repeat the action on another item.

ID: 062
Type: Request
Status: Open
Pri: 3
Opened:
Est: 2
Closed:
Sys: TOC
Mod: map
Short: Copy Overlay shouldn't fill in name.
Description: Copy Overlay dialog user interface problem. Selecting an overlay under the Copy (Overlay dialog) function should not enter the filename of the selected overlay in the newname box. This is confusing.

ID: 101
Type: Request
Status: Open (deferred)
Opened: 90/12/03
Sys: TOC
Mod: map
Description: Checkpointing (whether implicit or explicit) should save the overlay currently being edited into a temporary location. Upon startup the original overlay (i.e. not the temporary one) should appear in the overlay stack. When the user goes to edit this overlay, he or she should have the option of continuing to edit the temporary overlay or of ignoring the changes in the temporary and reverting back to the original.

ID: 104
Type: Request
Status: deferred
Pri: 3
Opened: 91/08/01
Est: 2
Closed:
Sys: TOC
Mod: msg
Short: Restrict location fields to tbd.

Description:	Location fields should be restricted to only valid locations in the terrain database.

ID:	109
Type:	Request
Pri:	3
Opened:	91/01/14
Status:	Open
Sys:	TOC
Mod:	msg
Est:	10
Closed:	
Short:	Update remote msg viewers.
Description:	Viewers open on remote workstations become obsolete. (Do not update on line).

ID:	141
Type:	Request
Status:	Open
Pri:	3
Opened:	
Est:	
Closed:	
Sys:	TOC
Mod:	all
Short:	Support list multiple selection.
Description:	BnTOC software should allow multiple selection of messages, folders, overlays, and formats where-ever it makes sense. The multiple selection policy should be consistent for all of these.

ID:	143
Type:	Request
Status:	deferred
Pri:	2
Opened:	91/01/21
Sys:	TOC
Mod:	fmt
Short:	New format name didn't appear in list.
Description:	A saved format name should appear in the format module immediately after it is saved. This does work, but it is confusing if the user has a different type of format selected than the newly saved format (in which case the new name *shouldn't* appear in the list.

ID:	156
Type:	Request
Status:	Open

Pri:	3
Opened:	91/03/14
Est:	1
Closed:	
Sys:	TOC
Mod:	msg
Short:	Add confirmation to msg delete.
Description:	Delete Messages operation requires a confirmation dialog.

ID:	157
Type:	Request
Status:	Open
Pri:	3
Opened:	91/03/14
Est:	35
Closed:	
Sys:	TOC
Mod:	ckpt
Short:	Enhance checkpoint/restart.
Description:	Restarting does not properly clean up. Restarting does not properly close all open message viewers,message composers, formats, and subdialogs. To be properly done, this requires a two pass restart mechanism.

ID:	170
Type:	Request
Status:	Open
Pri:	3
Opened:	91/03/14
Est:	1
Closed:	
Sys:	TOC
Mod:	msg
Short:	Add Field Titles to the Folder Viewers.
Description:	Add a Field Title string to the Folder Viewers and the Journal to explain each of the components of the message summary strings: Status DTG Orig Title Summary Action Taken

ID:	184
Type:	Request
Status:	Open
Pri:	3
Opened:	
Est:	1
Closed:	
Sys:	TOC

Mod: workbook
Short: Role-dependant lists of Standard Folders.
Description: Need to be able to specify separate lists of Standard Workbook Folders for each of the BnTOC roles.

ID: 197
Type: Request
Status: Open
Pri: 3
Opened: 91/03/06
Est: 2
Closed:
Sys: TOC
Mod: map
Short: Set unit size on TOC/CP.
Description: For unit symbols, change the unit TOCs to TOC/CP and be able to edit the unit size field.

ID: 200
Type: Request
Status: Open
Pri: 3
Opened: 91/03/06
Sys: TOC
Mod: map
Est: 3
Closed:
Short: Unit size should scale for CMs.
Description: The unit size designator does not scale for graphic control measures that are drawn on the map (i.e.boundaries).

ID: 203
Type: Request
Status: Open
Pri: 3
Opened: 91/03/06
Sys: TOC
Mod: map
Est: 2
Closed:
Short: Make object menus icon-type sensitive.
Description: The middle mouse button operations should be disabled for margin arrows for the following icon types. POSNAV icons - All functions disabled. Report icons - All functions except "View" should be disabled. This is because the resulting function cannot be observed and the function does not make sense.

ID:	206
Type:	Request
Status:	Open
Pri:	3
Opened:	91/03/03
Est:	3
Closed:	
Sys:	TOC
Mod:	msg
Short:	Gray "Route" btn when no msg selected.
Description:	Need an error dialog for "Route" message function when no message is selected. On the message folders, if "Route" is selected and no report from the list is selected, do not bring up the window associated with that function. Since you will eventually have the error message pop-up, have the error pop-up appear when the function is selected or disable/shade these functions until a report is selected from the list.

ID:	212
Type:	Request
Status:	Open
Pri:	3
Opened:	91/03/21
Sys:	TOC
Mod:	fmt
Short:	Need Collection format template.
Description:	Add the Collection format template.

ID:	223
Type:	Request
Status:	Open
Pri:	3
Opened:	91/03/27
Est:	1
Closed:	
Sys:	TOC
Mod:	msg
Short:	Clear the folder name after each create.
Description:	Clear the folder name field in the workbook index dialog after each operation. The folder name field in the workbook index dialog should be cleared when the user hits the create button so that the user can easily enter the name of the next folder to create.

ID:	247
Type:	Request
Status:	Open
Pri:	3
Opened:	91/09/16

Est: 1
Closed:
Sys: TOC
Mod: msg
Short: Remove own WS from REMOTE.
Description: Remove own WS from REMOTE. Each WS has all WSs on the remote menu.
Priority: LOW

ID: 248
Type: Request
Status: deferred
Pri: 3
Opened: 91/09/16
Est: ??
Closed:
Sys: TOC
Short: Menu bars and spot menus act different.
Description: Standardize menu access. All Communications and Planning Display, Map Display, and overlay attribute menus are accessed by clicking. Overlay symbol, report icon, and POSNAV icon menus are accessed by dragging. Fran's clarification: All icon (POSNAV, report) or overlay object menus are accessed by dragging (have to hold the button down to keep the menu open: dragging). BBN clarification: This is the difference between how Motif menu bars and spot work. Clicking on an item in the menu bar brigs up a menu that stays up. A spot menu is removed as soon as button released.

ID: 249
Type: Request
Status: Open
Pri: 3
Opened: 91/09/16
Est: 1
Closed:
Sys: TOC
Mod: Motif
Short: Cascading spot menus hard to use.
Description: Improve usability of cascading menus. These menus require precise selection. If the cursor falls off the calling option the second-level menu still appears (but no selection from it can be made). This is probably an operating system problem, but still worth noting. May attempt to alleviate problem by initially placing cursor nearer right-hand-side of spot menu and/or use larger font in menu.

ID: 250
Type: Request
Status: Open

Pri: 3
Opened: 91/09/16
Sys: TOC
Mod: msg
Short: "Add component" for aggregates.
Description: Implement "Add component" (?). This functionality and the concomitant "C" status code was never implemented. What is its status? If it will not be implemented, then we could do away with the "Add Component" button on aggregate reports.

ID: 251
Type: Request
Status: Open (deferred)
Pri: 1
Opened: 91/09/16
Sys: TOC
Mod: msg
Short: Provide message alerts.
Description: Provide message alerts. Consider providing auditory and visual signals for message receipt.

ID: 252
Type: Request
Status: Open (deferred).
Pri: 1
Opened: 91/09/16
Sys: TOC
Mod: map
Short: Provide UTM loc via mouse click.
Description: Provide UTM grid location on call via the third mouse button.

ID: 253
Type: Request
Status: Open (deferred).
Pri: 1
Opened: 91/09/16
Est: 8
Closed:
Sys: TOC
Mod: graph
Short: Improve Add/Delete/Move point usability.
Description: Improve editing capabilities for graphics tools. Add, Delete, and Move point are really hard to use on arrow tips and longer/bigger control measures.
Priority: HIGH. Fran's clarification: Improve editing capabilities: The biggest problem was the "point" editing. A more "mac-like" interface is the simple answer (look and feel, aside).

ID:	257
Type:	Request
Status:	Open
Pri:	3
Opened:	91/09/16
Est:	3
Closed:	
Sys:	TOC
Mod:	msg
Short:	Gray-out unavailable menu options.
Description:	Gray-out nonavailable menu option. For example, when viewing messages in the InFolder, the InFolder option in the routing menu should be grayed out (permanently removed?); likewise, routing menus called from a folder should have that folder grayed out.

ID:	259
Type:	Request
Status:	Open
Pri:	3
Opened:	91/09/16
Est:	5
Closed:	
Sys:	TOC
Mod:	map
Short:	Rotatable graphics objects.
Description:	Provide the ability to rotate graphic objects.

ID:	261
Type:	Request
Status:	Open
Pri:	3
Opened:	91/09/16
Est:	3
Closed:	
Sys:	TOC
Mod:	map
Short:	Make POSNAV spot menus blue.
Description:	Make POSNAV icon boxes (i.e. the spot menus from which you access the aggregate menu) BLUE. Then, when editing you can distinguish them from overlay objects.

ID:	284
Type:	Request
Status:	open
Pri:	3
Opened:	91/11/21
Est:	1

Closed:	
Sys:	TOC
Mod:	graph
Short:	Legend too long in Journal.
Description:	In the journal folder, the entire legend isn't visible unless the window is expanded. Suggestions included increasing the size of the window or putting the legend on two lines.

ID:	287
Type:	Request
Status:	Open
Pri:	3
Opened:	91/11/21
Est:	1
Closed:	
Sys:	TOC
Mod:	msg
Short:	Want feedback on <CR> in composers.
Description:	When typing in the "Where" fields, the user needs to hit return to really enter the values (for example, to get the heading from the map). There should be some feedback for this operation.

ID:	290
Type:	Request
Status:	Open
Pri:	3
Opened:	91/11/21
Est:	1
Closed:	
Sys:	TOC
Mod:	msg
Short:	Msg viewers hide others.
Description:	Sometimes, multiple message viewers are created directly on top of each other. This is annoying.

ID:	292
Type:	Request
Status:	Open
Pri:	3
Opened:	91/11/21
Est:	3
Closed:	
Sys:	TOC
Mod:	graph
Short:	Want area or point zoom-in.
Description:	People wanted the ability to zoom in on a selected point or area.

ID: 296
Type: Request
Status: Open
Pri: 3
Opened: 91/12/06
Est: 3
Closed:
Sys: TOC
Mod: fmt
Short: Collapse format directories.
Description: Store all formats in the same directory. Don't make the user select a format type to operate within. Make all formats appear in the list simultaneously.

ID: 303
Type: Request
Status: Open (deferred).
Opened: 91/12/05
Est: 5
Closed:
Pri: 2
Mod: map
Short: Embed the icon in the arrow which points to it
Description: For some icons, when they are outside the borders of the map, an arrow is drawn pointing in the direction of the location of the icon. ARI wants a hands-off interface, so that the soldiers can see what kind of icon the arrow is pointing to without having to select anything. Their recommendation is to draw the icon inside the arrow. Once BnTOC and IVIS code is merged, IVIS will get BnTOC style arrows for free, which require the soldier to touch the arrow to see what it is. To embed the icon in the arrow will take an additional person-week.

ID: 369
Type: Request
Status: Open
Opened: 91/12/05
Est: ?
Closed:
Pri: 3
Sys: TOC
Mod: Message
Short: Could not view messages at remote WS if message not relayed.
Description: Could not "Remote" and view messages in other WS folders if those messages had not been relayed. Heiden comment: Introduce the ability to "pull" files and folders other WS except "Work in Progress" files or "Draft" files. The TOC officer can designate a file as a "Draft" to prevent it from being readable from remote workstations.

ID:	400
Type:	Request
Status:	Open
Opened:	91/12/05
Est:	3-10?
Closed:	
Pri:	3
Sys:	TOC
Mod:	message
Short:	Grid locations entered in reports via keyboard don't remain
Description:	This is a feature not a bug. This should be a request to change the message composers not to require a carriage return to enter a value. However, this needs to be examined in the larger context of consistent input into text fields for all the BnTOC.

ID:	401
Type:	Request
Status:	Open
Opened:	91/12/05
Est:	1
Closed:	
Pri:	3
Sys:	TOC
Mod:	map
Short:	Unit size designator should appear in the middle of lines
Description:	When drawing lines, unit size designator appears at end of line, instead of middle.

ID:	406
Type:	Request
Status:	Open (deferred)
Opened:	91/12/05
Est:	5
Closed:	
Pri:	2
Sys:	TOC
Mod:	message
Short:	"Draft" files should not be visible from remote workstations.
Description:	Introduce the ability to mark files and folders as "Work in Progress" files or "Draft" files to prevent them from being viewed from remote workstations.

ID:	407
Type:	Request
Status:	Open
Opened:	92/02/21
Est:	1

Closed:
Pri: 3
Sys: TOC
Mod: map
Short: Quick access to overlay stack and bringing overlay to top.
Description: Change overlay top text label to cascade button, picking button brings overlay to top.

ID: 408
Type: Request
Status: Open
Opened: 92/02/26
Est: 1
Closed:
Pri: 3
Sys: TOC
Mod: map
Short: Allow overlay functions in Edit Mode.
Description: Allow user to perform normal overlay functions while in edit mode. Provide user with option for cancelling, using old or saving new overlays.

ID: 409
Type: Request
Status: Open
Opened: 92/02/21
Est: 1
Closed:
Pri: 3
Sys: TOC
Mod: map
Short: Provide overlay "revert" function.
Description: Allow user to selectively revert overlays to stored version on disk.

ID: 410
Type: Request
Status: Open
Opened: 92/02/21
Est: 1
Closed:
Pri: 3
Sys: TOC
Mod: map
Short: Provide selective overlay save screen.
Description: Provide save dialog where user is able to pick any overlay and save it.

ID: 411
Type: Request

Status: Open
Opened: 92/02/21
Est: 1
Closed:
Pri: 3
Sys: TOC
Mod: map
Short: Unit Size designators sometimes drawn improperly.
Description: When a line is first drawn, if the line only has 2 points or if the unit size designator is placed on an acute angle, the designator is not drawn completely. It is drawn properly if the map is redrawn.

ID: 412
Type: Request
Status: Open
Opened: 92/02/21
Est: 1
Closed:
Pri: 3
Sys: TOC
Mod: map
Short: Make Create popup easier to use.
Description: Possible warp cursor into text field so user doesn't have to move it there.

ID: 428
Type: request
Status: Open
Opened: 92/04/21
Est: 2
Closed:
Pri: 2
Sys: BnTOC
Mod: map
Short: Overlays can now be sent to everyone, not just bn command net
Description: In the past, overlays could only be sent on the bn command net. The popup for sending overlays only allows this option. Now overlays can and should be allowed to be sent anywhere. The popup must change to include all routings, as well as making sure the underlying code is there to handle overlays in the in-folder.

ID: 510
Type: Request
Status: Open
Opened: 92/09/15
Est: 1
Closed:
Pri: 3

Sys: BnTOC
Mod: tooe
Short: Provide label in summary circles
Description: The operational effectiveness summary circles need appropriate labels for ammo, equipment, fuel, and personnel.

ID: 531
Type: Request (BBN)
Status: Open
Opened: 92/09/15
Est: 1
Closed:
Pri: 3
Sys: BnTOC
Mod: Sit display
Short: Grey out unneeded map functions
Description: Desensitize all of the overlay and stacking functions, except show text and rotation functions. The users have gotten into the habit of removing overlays posted to the sit display from the sit display itself. This has caused problems with incongruities between the workstations and the sit disp. Not allowing the users to use the system in this way is probably the most foolhardy approach.

b. Command and Control Display. (CCD)

ID: 316
Type: Request
Status: Open
Opened: 91/12/05
Est: FS
Closed:
Pri: 1
Sys: IVIS
Mod: rep
Short: Provide preplanned target option or target reference points
Description: Fire support planning as outlined in FS TOC WS functional description establishes predesignated artillery concentrations which are generally numbered with two alpha characters and four numerals. These numbers are usually assigned by the supporting artillery. TRPs are usually assigned by a unit which uses the TRP to identify a specific location on the ground for orientation purposes. Fire planning, on the other hand, assigns Concentration numbers which can be used to call-in supporting fires. TRPs may be submitted to the FSE for addition to the fire plan. For CVCC purposes the Call for Fire format should be modified to permit calling for fire either by coordinates or by Concentration Number. When the format is used when the "Where" field is highlighted the "Conc Nr" field should also highlight. An entry in one field should lock out the other field. The "Conc Nr" field (for CVCC purposes) should have the alpha

prefix "AB" entered as the assigned prefix for the CVCC supporting artillery designation. The standard keypad described previously should be provided to permit entry of the four digit numeric designation of the concentration number. Further discussion is provided in the FS TOC WS functional description.

ID: 324
Type: Request
Status: Open
Opened: 91/12/05
Est: refer to logistics module of the css toc
Closed:
Pri: 1
Sys: TOC/IVIS
Mod: rep
Short: Detailed logistics info should be included in sit report
Description: Need clarification.

ID: 327
Type: Request
Status: Open
Opened: 91/12/05
Est: 2
Closed:
Pri: 3
Sys: IVIS
Mod: map
Short: Provide location and elevation for any point on the map
Description: ARI would like the user to be able to retrieve the location and elevation of any point on the map. After discussion with ARI, BBN can determine when the map will be in a context for this function.

ID: 333
Type: Request
Status: Open
Opened: 91/12/05
Est: 2
Closed:
Pri: 3
Sys: IVIS
Mod: map, menu
Short: Provide data format options
Description: Provide the following data format options: a) mils versus degrees; b) 4-, 6-, and 8- digit grids; c) highlight or bold the digits to show axis break ES123456.

ID: 341
Type: Request
Status: Open
Opened: 91/12/05
Est: 5
Closed:
Pri: 3
Sys: IVIS
Mod: map
Short: Provide alternate scroll options
Description: ARI wants the following alternative scrolling modes: a) in the map menu, include an input grid xxxxxx; b) for incoming messages and overlays, provide center and home functions. BBN wishes to point out that for option a, there is no complete alphanumeric keypad, and for option b, there is real estate problems in the show report menus. When these issues are resolved, the effort to implement the solutions will take 1 person-week.

ID: 347
Type: Request
Status: Open
Opened: 91/12/05
Est: 10
Closed:
Pri: 3
Sys: TOC/IVIS
Mod: com
Short: Provide system ack for some messages
Description: When certain messages are received, ARI would like an automatic acknowledgement sent to the sender. This requires software design discussion at BBN. This is a significant change.

ID: 348
Type: Request
Status: Open
Opened: 91/12/05
Est: 10
Closed:
Pri: 3
Sys: TOC/IVIS
Mod: com,rep
Short: Provide WILCO key for selected messages
Description: For certain messages, a WILCO button should be provided. If the soldier presses this button, a message goes to the sender of the message which indicates the soldier has read, understands, and will comply. This requires software design discussion at BBN. This is a significant change.

ID: 351

Type:	Request
Status:	Open (deferred).
Opened:	91/12/05
Est:	10
Closed:	
Pri:	2
Sys:	IVIS
Mod:	report
Short:	Modify/edit a received report
Description:	This changes the user interface in IVIS. A design discussion and decision making process will have to take place before this can happen.

ID:	352
Type:	Request
Status:	Open
Opened:	91/12/05
Est:	20
Closed:	
Pri:	3
Sys:	IVIS
Mod:	map
Short:	Modify/edit a received overlay
Description:	In order to do this, overlay editing capabilities must be added to IVIS.

ID:	460
Type:	request
Status:	Open
Opened:	92/07/09
Est:	2
Closed:	
Pri:	3
Sys:	IVIS and BnTOC
Mod:	cff reports
Short:	Adjust fire report not connected to a cff
Description:	There is a cff report id placed in the packet. It's just that nothing is done with it when the adjust fire report is displayed. It's unknown what should be done with it.

ID:	511
Type:	Request
Status:	Open
Opened:	92/09/15
Est:	1
Closed:	
Pri:	3
Sys:	CCD
Mod:	tooe

Short:	Separate heat and sabot
Description:	Heat and sabot values should be separated in the CCD ammo logistics reports.

ID:	519
Type:	Request
Status:	Open
Opened:	92/09/15
Est:	1
Closed:	
Pri:	3
Sys:	CCD
Mod:	standalone mode
Short:	Vehicle location should be a setable parameter
Description:	CCD own vehicle location should be a setable parameter for the standalone CCD.

ID:	524
Type:	Request
Status:	Open
Opened:	92/09/15
Est:	1
Closed:	
Pri:	1
Sys:	CCD
Mod:	graphics
Short:	CITV indicator on CCD difficult to see
Description:	CITV indicator on CCD tank icon needs to be dashed and longer

c. Commander's Independent Thermal Viewer (CITV).

ID:	355
Type:	Request
Status:	Open
Opened:	91/12/05
Est:	?
Closed:	
Pri:	3
Sys:	CITV
Short:	Map to sensor slew
Description:	Allow the selection of a point on the map which will, upon command, cause the CITV head to be laid on the azimuth from current tank location to the selected location.

ID:	356
Type:	Request

Status: Open
Opened: 91/12/05
Est: ?
Closed:
Pri: 3
Sys: CITV
Short: Dedicated function switch with CITV integration
Description:

ID: 357
Type: Request
Status: Open
Opened: 91/12/05
Est: ?
Closed:
Pri: 3
Sys: CITV
Short: Depict lase azimuth/range graphically, range digitally on CCD
Description: When lasing to a target (or terrain location) display a ray from own tank icon on the CCD to the target and display the range digitally beside the ray. Maintain on the CCD for 20 sec. duration, then erase.

ID: 358
Type: Request
Status: Open
Opened: 91/12/05
Est: ?
Closed:
Pri: 3
Sys: CITV
Short: Set auto scan sector using CCD map
Description: Provide a mechanism for setting CITV scan limits by selecting R & L sector limits on the CCD.

ID: 359
Type: Request
Status: Open
Opened: 91/12/05
Est: ?
Closed:
Pri: 3
Sys: CITV
Short: Ability to transmit fire sectors to coordinate fire plans
Description: Using a mechanism similar to the scan limit sector set (See ID: 358) allow tank cmdrs to transmit primary fire sectors.

ID: 360
Type: Request
Status: Open
Opened: 91/12/05
Est: ?
Closed:
Pri: 3
Sys: CITV
Short: Set CITV Auto Scan sectors relative to current tank position
Description: Provide ability to set CITV Auto Scan sectors according to your tank (e.g., over the front or rear fenders, etc.) in addition to setting according to direction.

d. Semi-Automated Forces (SAFOR).

ID: 375
Type: Request
Status: Open
Opened: 91/12/05
Est: 1
Closed:
Pri: 1
Sys: SAF
Short: Need global commands available
Description: Need global commands available (E.g., stop all units with single command).

ID: 376
Type: Request
Status: Open
Opened: 91/12/05
Est: 2
Closed:
Pri: 1
Sys: SAF
Short: Need ability to "Scroll Lock" the report log window
Description: Need ability to "Scroll Lock" the report log window to allow SAFOR operators to read reports.

ID: 393
Type: Request
Status: Open
Opened: 91/12/05
Est: 15
Closed:
Pri: 3
Sys: SAF
Short: RESUME to the nearest point on original route after TAC/E

Description:	When a unit executing a rout has been given TAC/E commands taking it off the route, and is then told to "Resume", the unit should go to the nearest point on the route and continue from there, rather than from where the route was left.

e. SEND Utility.

ID:	517
Type:	Request
Status:	Open
Opened:	92/09/15
Est:	1
Closed:	
Pri:	3
Sys:	send
Mod:	vignettes
Short:	Want to specify network by report
Description:	CVCC-Send reports placed within vignette files cannot be sent on different nets. BDM desires this feature.